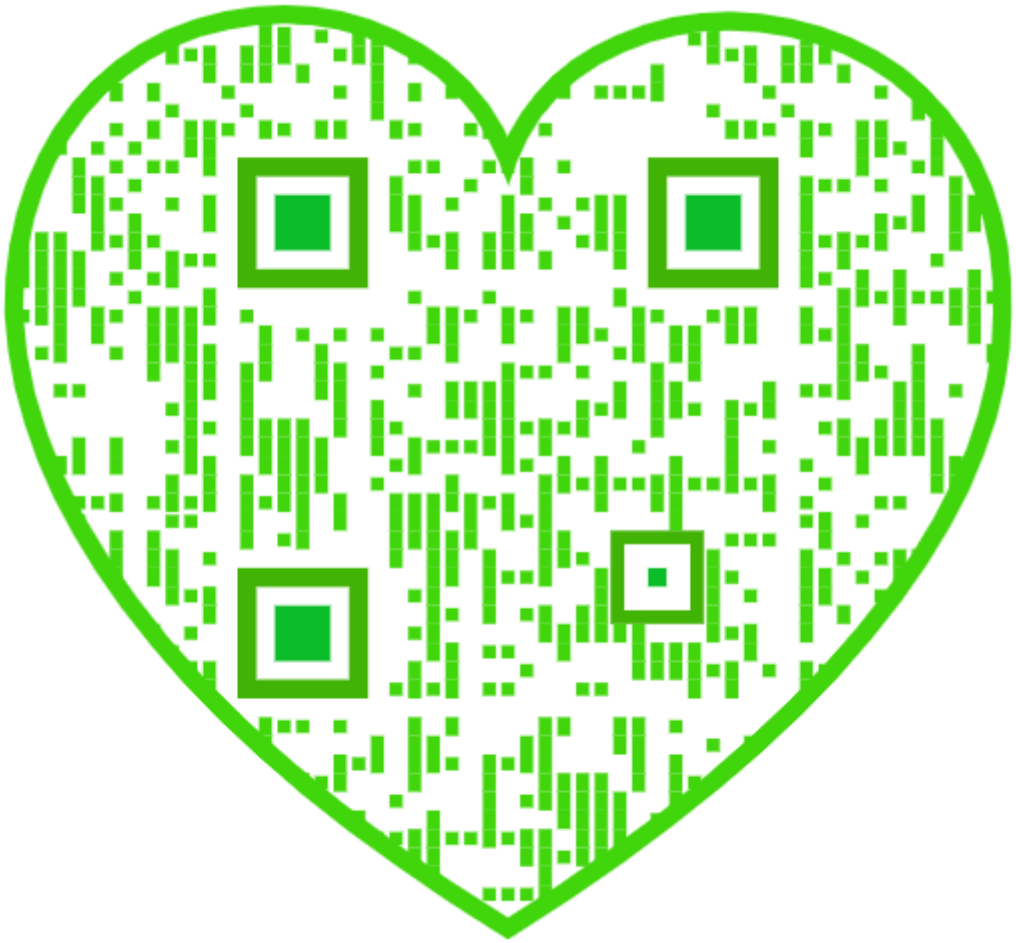
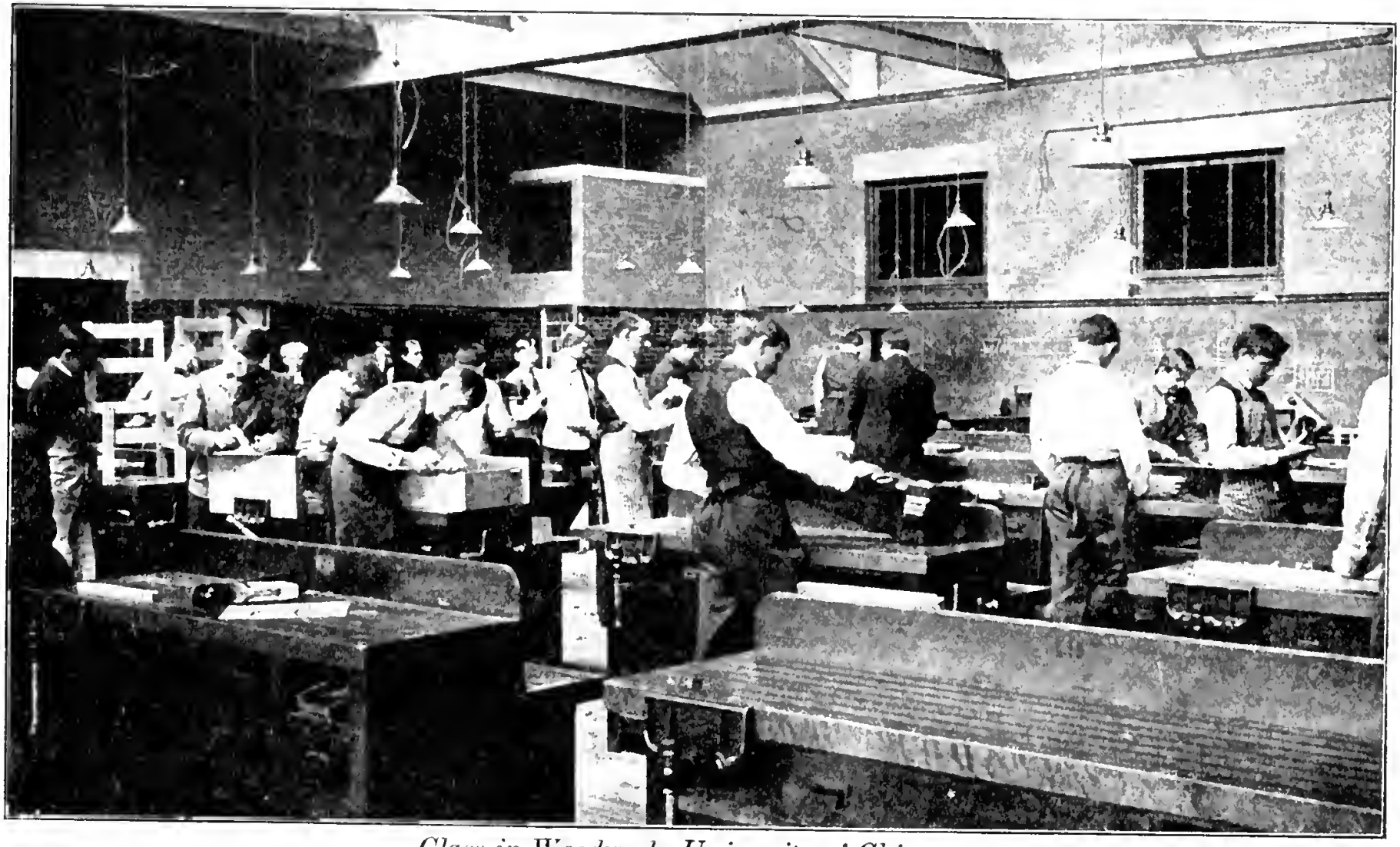
ELEMENTARY WOODWORK

FRANK HENRY SELDEN





Class in Woodwork, University of Chicago.

ELEMENTARY WOODWORK

FOR USE IN

MANUAL TRAINING CLASSES

BY

FRANK HENRY SELDEN
AUTHOR OF "ELEMENTARY TURNING" AND "ELEMENTARY CABINETWORK"

FULLY ILLUSTRATED

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Preface

The object of this work is to place before pupils who are beginning woodwork such information as will lead to a correct use of the tools and lay a good foundation for advanced work without lessening in any way the other benefits of school shop work.

It is designed for elementary rather than technical instruction, and therefore many problems and suggestions found in other works have been omitted. Great care, however, has been taken to arrange and illustrate the exercises employed so that pupils will avoid the common error of using tools improperly in the first years of work, and thus escape fixing habits which later will cause much trouble. We are certain there is no need of using tools improperly in the first years of shop work.

The work is so arranged that each new lesson contains a step in advance, yet is so closely related to the previous exercise that an ordinary pupil may properly comprehend and execute the new problem.

This book is intended for class use, and the author has endeavored so to arrange and grade the exercises that they may be followed very closely. Where no preliminary exercises are made, and the pupils proceed at once to the construction of some complete object, the problems should be studied

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topically as the pupil has need of them. The complete index and the cross references found in the text will aid greatly in finding any desired instruction. The special information required by the instructor will be found in another volume

If the methods of doing work given in the following pages are judged from the standpoint of first-class practical workmen they will be found correct in every case. Where there is a choice of methods, the one which is considered best for the pupil's use is given. The lessons have been tested carefully with many pupils, and the various processes tested not only in the school room, but also in years of practical work among mechanics. The foundation principles involved are treated so thoroughly that no pupil, after completing the book, need fear to use these methods in any first-class shop. In shops where special methods are employed these lessons will be found to have given a broad basis on which to build any special line of mechanical work. Above all, these exercises will give a drill in system, careful forethought, and intelligent perseverance which will be of great value to any pupil, either boy or girl, and will well repay the effort, even though the pupil may never use such tools after leaving school. Care must be taken to do the work thoroughly and earnestly in order to receive the full benfit of the course. Whenever possible, one hour and a half each day should be devoted to shop work.

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INTRODUCTION

These lessons take up the common tools in the order which the author has found to be best. They are so graded that the pupil should be able to execute each exercise in a satisfactory manner. The chief difficulties are carelessness and thoughtlessness. If the pupil reads carefully the entire text for each exercise before beginning it, and then re-reads the text, step by step in order, as the work progresses, he will find little difficulty in making proper progress

As each tool is taken up, the pupil should turn to part III and study carefully what is said about that particular tool; and each day, until the lessons are mastered, review what is said in regard to the use of the tools in the lessons and also the description of the tools in part III. Each new lesson depends very largely upon those preceding. Therefore, only by a constant review will the pupil get the greatest possible benefit from his study. Although the directions are quite explicit, an abundance of opportunity is left for individuality in work.

If proper care is taken there will be no necessity for giving any pupil a second piece of material for any exercise. This method is not only more logical,

but more satisfactory to the pupils when they realize that it results in greater good to themselves. The author has many times had pupils, after a piece has been finished, voluntarily express great satisfaction at having been kept so long at the exercise, although considerable effort had been required to do so. It is conquering a difficult exercise that benefits the pupil and gives real interest in the work. The grade established on the first piece is apt to continue through the entire course. Pupils who conquer thoroughly the first difficulties, though perhaps at first dropping behind those more easily satisfied, are quite likely to work so much more rapidly later on that they will more than make up the loss of time on the first exercises.

These lessons will be found very useful when constructing complete articles. Where no model joints are made, the lessons should be studied topically, each exercise being taken up as it occurs in the article being constructed.

Personal Equipment

Each pupil must provide himself with a suitable apron, an oilstone, a pocket-knife, pocket-rule, pencil, clothes-brush, soap, and towel. Each of these articles must be plainly marked with the pupil's name. No pupil should be admitted to the class until he has his personal equipment and each article properly marked. These articles may be kept either in the bench

drawer or in the locker. For description and suggestions in regard to the above articles, see Part III.

School Equipment

In addition to the personal equipment, each pupil is provided with such tools and materials as are required for the exercises. A part of these tools are used by all of the pupils who work at one bench, and are called the bench-set. They are not likely to be injured, and therefore may be kept in a drawer unlocked. They consist of hammer, backsaw, mallet, try-square, and tee bevel. Handsaws, ripsaws, large square, etc., are kept in the tool room and given out as required.

Each pupil is furnished with an individual drawer containing one guage, three bits ($\frac{1}{4}$ inch, $\frac{3}{8}$ inch, and $\frac{7}{16}$ inch), three chisels ($\frac{1}{4}$ inch, $\frac{3}{8}$ inch, and $\frac{7}{8}$ inch), and two planes (a jack plane and a smooth plane).

Regulations

Pupils should enter and leave the room in an orderly manner. Conversation during work hours is prohibited, as it is impossible for pupils to do their best work when there is conversation in the room.

Each pupil should have his own materials and tools as required, so that he may remain at his place during the recitation period. Every piece of material, including sandpaper, must be plainly marked

by the pupil as soon as received. When the name is erased in working the piece, it should be placed on another part. When the work is completed, the name and date of completion should be plainly written on one end, or on some other convenient part of the work. So far as possible, the work should be kept in the bench drawer. Work which has to be left on the finishing table to dry will be cared for by the instructor.

Pieces of material left over that are large enough to be used for an exercise should be left on top of the bench or handed to the instructor. They should never be destroyed, mutilated, hidden, or thrown on the floor. At the close of each lesson the tools must be put in place. The bright parts which have been moistened by contact with the hands should be wiped with oily waste. Tools which require grinding may be reported to the instructor or left upon the bench. Each pupil must have a key to his own drawer, and will be held responsible for the tools, etc., which it contains. In case any tool or bit of material has been taken or tampered with during the absence of a pupil, it should be reported to the instructor as soon as discovered.

At the close of the recitation, each pupil must brush all shavings and dirt from his bench; and when cleaning the bench care must be taken that no dirt is thrown on to adjoining benches. The lavatories are for use, and every pupil should wash

his hands and brush his clothes before going to another recitation.

At the close of the year each pupil may remove the work he has completed by paying for the materials used, except such pieces as are needed in the school for exhibition.

For each exercise a sufficient amount of material will be given each pupil. This material will be sufficient to complete the exercise properly, and only in very extreme cases shall more material be given. In no case shall any credit be given for work done on extra material. The first piece given must be finished as well as possible, even though very incorrect or under size; and the record will be made up from this piece. Sandpaper should not be used on any exercise until that exercise has been passed upon by the instructor.

Notice

No cutting, or marking, or jamming of the benches will be tolerated. On discovery of any injury to the bench the pupil will be required to pay a fine or be suspended from the class. Broken handles or tools will be replaced at the pupil's expense.

The bench-hook and bench-board are to protect the bench from injury by saws, chisels, or other tools. Unnecessary cutting or injury to the bench hook or bench-board will be treated the same as injury to the bench.

The Illustrations

In all the work illustrated in this book the positions should be natural and easy. Do not try to follow any particular rule or to copy any person's position. Fig. 1 and the illustrations which follow are from pupils at work and not posed to suit the fancy of any one. They are good examples to be studied rather than copied. They illustrate general principles rather than bits of detail. They are scrupulously correct for the

Fig. 1. Planing.

particular person photographed, but may not be exactly the proper position for pupils of different height or of different physique.

If you find yourself using much strength it is probably caused by not using the tools properly. Although you are not expected to imitate the positions of other pupils, yet you must ever keep in mind that there is a correct way in which to use the tools. The correct way is the easiest and the best way, and if you have become accustomed to using the tools improperly, change your method at once. Do not insist that your way is easier or better for you. Change to the methods given in this book at once, and you will soon be doing more and better work.

Fig. 2. Sighting for Straightness.
Be particular to have the light fall properly upon the piece. Experiment by holding the piece in different positions.

Fig. 3. Testing from Edge to Edge.
The try-square may be held either side up, but the beam should not be placed against the edge in making this test. Compare this use of the try-square with that shown in Fig. 12.

PART I

Elementary Exercises

LESSON I

To True the First Surface of a Piece of Wood

Material—A piece of pine $1\frac{3}{8}$ inches thick, $1\frac{3}{4}$ inches wide, and $12\frac{1}{2}$ inches long.

Examine the piece thoroughly for broken corners, checks, knots, and other defects. Select for this lesson the best surface. Examine very carefully the surface to be worked; first, by sighting with the eye from end to end to determine if it is straight (Fig. 2); second, by applying the try-square blade as shown in Fig. 3 to determine if it is straight across from edge to edge. Next, with both hands hold the piece between you and the side light, and sight across the piece from edge to edge, tilting it to such an angle as will make the line of sight pass just over the front edge to the back edge as shown in Fig. 4. If the piece is out of wind both back corners of the surface will show equally. If the piece is in wind one back corner will show more than the other back corner and the high back corner may be planed down. Although we should always look for a high back corner, we

may take the piece out of wind by planing the alternate front corner. It is usual to plane an equal amount from each of these corners or more from the one which is thicker. Place the piece on the bench as shown in Fig. 1. Do not put the piece in the vise.

Fig. 4. Looking for Wind or Twist.

Remember to repeat the three tests after every few strokes of the plane, so that when the piece is out of wind it will be straight from end to end, and also from edge to edge. A straight edge may be used for testing the straightness of the surface. (See Fig. 5.)

An excellent method for aiding the eyes in testing is to plane up three pieces as nearly perfect as

possible and after testing them with the eyes and try-square, try them together. First test number one with number two, then number one with number

Fig. 5. Using a Straight Edge. Learn to examine the edge as shown in Fig. 2. The straight edge should be used only to see whether the first test has been successful.

three, and then number two with number three. Continue to plane and test them in this manner until each one will fit the other two. This exercise will well repay the time. The three pieces required for the bench-hook (Lesson 7) may be dressed up at once and compared in this manner.

If in planing the surface does not work perfectly smooth, make a careful examination of the plane.

When the plane is in proper order it will make a shaving nearly the full width of the bit. The shaving should be thickest at the center, and curve slightly to the edges. If you are not strong enough to cut a wide shaving, the bit may be ground so rounding that it will cut only a very narrow shaving. If the plane is cutting too thick or too thin a shaving, turn the brass milled thumb-nut, which is under the plane iron, until the proper thickness of cut is obtained. As the plane cuts deepest at the center of the cutting edge, the plane should be held parallel with the sides of the piece and with the center of the bit over the place requiring the heaviest cut. (See Fig. 6.) Lift or tilt the plane on the return stroke so that the bit will not touch the wood. (Figs. 7, 8, 9.) Hold the plane firmly, but do not attempt to make it cut by using an extreme amount of pressure. Bear down on the toe, or front end, of the plane in starting (Fig. 1), and on the opposite end, or heel, in finishing the stroke (Fig. 10). In case a shaving is to be taken off only a part of the length of the piece, raise the heel of the plane gradually while it

Fig. 6. Jointing an Edge. The plane may be moved along either side or along the center.

is moving forward, or in case the shaving is to commence part way of the length, lower the heel to the cut while the plane is moving forward. Do not be satisfied until you have a surface not only straight and out of wind, but also entirely free from any roughness caused by the plane.

Fig. 7. Tilting the Plane. This is to avoid dulling the cutting edge on the return stroke.

You will probably discover that it is quite difficult to plane the piece so that it will be straight and square to the extreme ends. The reason for this is that you do not bear down enough on the toe of the plane and lift enough on the heel of the plane as you start the stroke; and in finishing the stroke you do not bear down enough on the heel and lift enough on the toe of the plane. The gradual changing from bearing on one end of the plane to bearing on the other end of the plane is the one very important point which you must learn if you are to do good work.

Fig. 8 Lifting the Plane. This is to avoid dulling the plane on the return stroke.

You will soon discover that some pieces of wood plane more smoothly in one direction than in the other. Always plane in the direction that will produce the smoothest surface. This is called planing with the grain. In some pieces the grain runs in both or many directions, and it is impossible to plane them entirely smooth. Such pieces are sometimes finished with a scraper.

Fig. 9. Swinging the Plane to one Side. This keeps the bit from touching the material on the return stroke.

In getting the surface to the proper shape use as little of the material as you possibly can. This not only will save much time and material, but is also the mark of a skilled workman.

Fig. 10. Position in Finishing the Stroke.

When the first surface is finished, make a pencil mark on it about 1 inch long. This mark should be near the center of the piece, from end to end, and at nearly right angles to the edge, and should extend to the edge which is to be planed

next (Fig. 11). This is called a face-mark, and not only indicates that the surface has been properly shaped, but also that measurements and lines are to be made from this side.

This piece should always be held by placing the end against the bench stop. If there is a tail vise do not use it, for you will be more certain to use the plane properly if the piece is not held rigidly; and when the plane is properly used the piece will not move from its place in front of the stop, and there will be no need of using the vise.

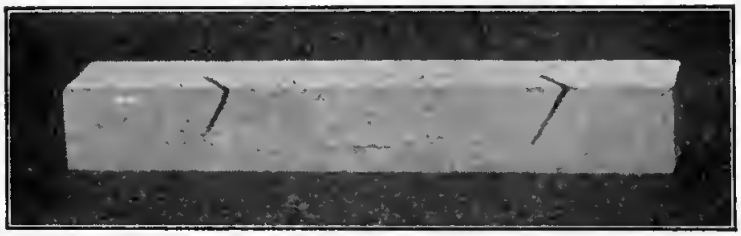


Fig. 11. Face-Marks. Unless the piece is to be cut in two but one set of face-marks is used. When there is but one set they are placed near the center.

LESSON II

To Plane an Edge at Right Angles to a Surface

The first edge, or second surface, is examined in but two ways: for straightness, as in Fig. 2, and to see whether it is at right angles to the first surface, as in Fig. 12. In using the try-square press the head or beam firmly against the face surface. The face surface is always the one having the face-mark. If the blade of the try-square does not touch the edge

across its entire width, plane down the high places until it does. Do not try to make the plane cut at one side by tilting it, but move the central part of the bit (the part which cuts the thickest shaving)

Fig. 12. A Try-Square on the First Edge. Observe carefully the position of the hands.

over the places requiring the heaviest shaving, as shown in Fig. 6.

Be careful to keep the edge straight and smooth. Avoid as much as you can taking shavings only a part of the length. Plan to have the last shaving extend the entire length of the piece. Move the plane parallel with the edge. Do not be satisfied

until the try-square touches the entire surface. Be very particular to have the edge straight to the extreme ends. Do not put this piece in the vise. When this edge is finished, make a face-mark on it the same as on the first surface, as shown in Fig. 11.

You should exercise care in selecting the edge to be first planed. Plan to remove as little material from this edge as possible, for this will become the working edge, and should therefore contain the best material. The greater part of the excess material is to be removed from the third and fourth surfaces. If the amount of waste is large enough, it may be removed by using the rip-saw first, and afterwards finishing with the plane.

LESSON III

Use of the Gauge

See that the spur is sharpened to a knife-like point, so that it will make a smooth line. Set the gauge by holding it in the left hand, the thumb under

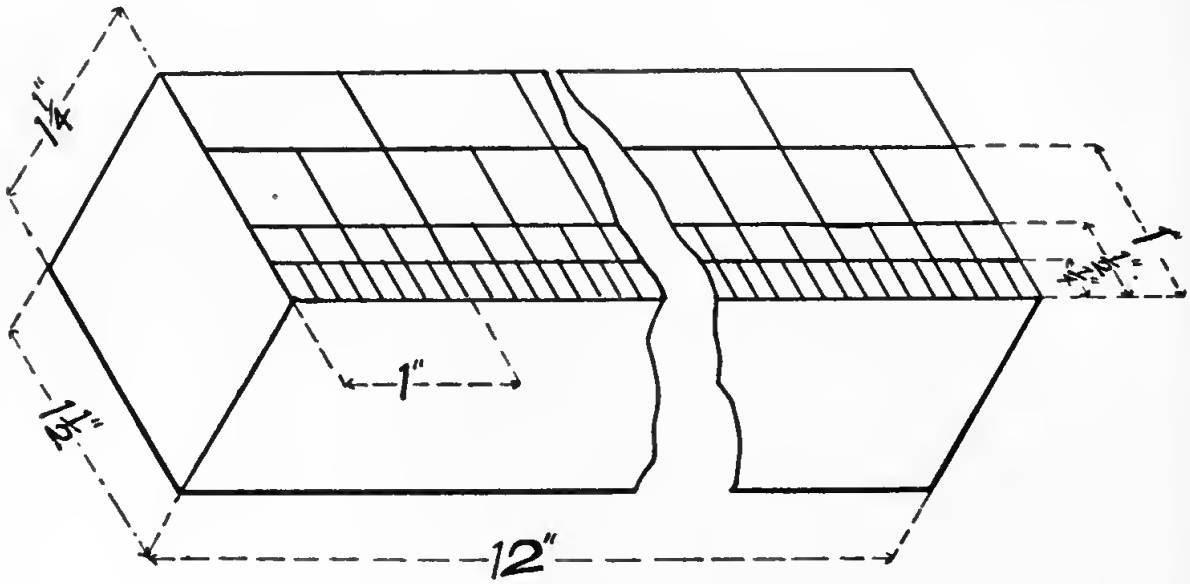


Fig. 13. First Piece or Rule.

the beam and against the head, the first finger on top of the head and the other fingers grasping around the beam. With the right hand hold the rule, opened to one foot long, against the head, and directly behind the spur and on top of the beam, Fig. 14. By pressing with the rule, or with the thumb and finger, the head will be moved until the proper line on the scale is brought directly behind the spur. Then lay the rule aside, holding the head in place by the pressure of the first finger of the left hand until the thumbscrew has been tightened with

the right hand. Test the gauge to see if it has been correctly set by applying the rule again.

Fig. 14. Setting the Gauge.

To draw the line, take the gauge in the right hand, three fingers grasping the beam—the first finger over the head and the thumb against the beam, and as nearly opposite the spur as is convenient. Always place the head of the gauge against a side having a face-mark.

Fig. 15. Drawing a Gauge Line.

Take the piece used in Lesson 2, and, with the gauge set to $\frac{1}{2}$ inch, draw a line on the side first trued, $\frac{1}{2}$ inch from the face edge. Before attempting to draw the line it is well to practice the movement of the hand and arm by rolling the gauge until the spur will not touch the surface of the piece, and then making the movement as if drawing the line the entire length of the piece. Next allow the spur to touch a very little, making a very light line. Gradually increase the strength of the line until a line of the proper heaviness has been produced.

Next draw a line $\frac{1}{4}$ inch from the face, and then a line 1 inch from the face, and lastly a line $1\frac{1}{2}$ inches from the face (Fig. 13). Make all these lines of equal strength and smooth and straight to the extreme ends. It is usually more convenient to rest the end of the piece against the bench stop; and, in order to draw the line to the extreme end of the piece, it will be necessary to roll the piece as shown at Fig. 16. Be careful to hold the work and gauge so that you can easily see how deep the spur is cutting, and also whether the head of the gauge is against the

Fig. 16. Finishing a Gauge Line.

face side. If you are careful in making a light line at first, you will have no serious difficulty in drawing a line through knots or over diagonal grain.

LESSON IV

Finishing the Third Side

Take the piece used in Lesson 3 and plane the third side or second edge, planing down to the $1\frac{1}{2}$ inch gauge line, making the piece $1\frac{1}{2}$ inches wide. It will be noticed that when you have planed sufficiently to remove the rough edge caused by the gauge spur that the piece is a very little less than $1\frac{1}{2}$ inches wide. This is caused by planing to the inside edge of the line. If you wish to have the piece full width you must set the gauge enough wider to allow for planing the line off.

Fig. 17. Measuring.

See that the edge is square by using the try-square as on the first edge (Fig. 12). If the edge is planed to the line, it should be straight, yet it is best to examine it very carefully near the ends and at the middle by using the rule as shown in Fig. 17. In measuring with the rule the fingers grasp the rule; the end of the thumb rests against the piece of wood, and the rule is moved until one of the inch graduations is at one edge of the piece. Do not place the end of the rule even with one edge of the piece. Always hold the rule on edge, so that the graduations will come in contact with the surface being measured. You may not be pressing hard enough on the toe of the plane in starting, or on the heel in finishing, the stroke, as directed in Lesson 1. Only by planing the piece straight to the extreme ends will you get the proper control of the plane. No mark should be placed on this side.

If you do not get the edge perfectly square and straight by the time you have reached the line, do not continue planing by guess, but draw another gauge line very near to the edge and try again to plane to a line. Perhaps your plane is set too heavy, or perhaps the iron has shifted so that it is cutting too much on one side. Examine your tools and the edge thoroughly before trying the second time; and then, by cutting a very thin shaving and testing the edge after each stroke of the plane, you should be able to get the edge exactly correct. If you fail

the second time, draw another line and try again and again until you do succeed in getting the edge exactly correct. Each time work more slowly and with more care. Keep a constant watch of the condition of the plane, for it is quite impossible to make the edge true if the plane is not properly set or is dull. Review often the directions for adjusting and sharpening the plane given in Part III.

LESSON V

Finishing the Fourth Side

Gauge the piece to $1\frac{1}{4}$ inches thick on each edge and plane down to these lines. Use the blade of the try-square as in Fig. 3 to see if the surface is straight from edge to edge or from line to line. You may also use the try-square as on the second and third surfaces, placing the head of the try-square against the surface which has a face-mark. Also measure with the rule at each corner, as in Fig. 17. If all these tests show your piece to be correct you will have done well. If the work is very accurate the square will fit the fourth surface when the beam is against the edge which does not have a face-mark. Do not plane the fourth surface to make the try-square fit in this position. This is only an additional test for proving the accuracy of the work. There should be no mark placed on this surface.

In case your piece is below size, do not discard it for another piece, but work it to a smaller size, testing it carefully to see that it is the same size at each end. Should you plane below your gauge line, do not attempt to complete the piece by simply planing and measuring, but set the gauge to the smaller end and draw a line entirely around the piece. Then plane carefully to this line, and test with the try-square and the rule.

LESSON VI

Laying off Spaces and Lining

Place the rule on the surface to be measured and, with the knife in the right hand and the back of the blade against the rule, as shown in Fig. 18, make a mark at the desired distance with the extreme point of the knife blade. Lay off as many points as you can without moving the rule.

Fig. 18. Marking off Spaces.

Take the piece used in Lesson 3, Fig. 13, and lay off twelve 1-inch spaces. Begin about $\frac{1}{4}$ inch from the end, so that there will be left at each end of the piece some waste material which may be cut off in finishing the ends after the scale is completed.

Place the point of the knife in the first mark and move the try-square up to the knife while holding it, as in lining the shelf border (Fig. 19). Hold the try-square firmly, and with the knife begin at the farther edge and draw a line across the piece close up to the blade of the try-square. In holding the try-square, it is best to place the thumb against the head, the first and second fingers on the blade, and the third and fourth fingers against the piece, as shown in Fig. 19. When the head of the try-square is on the opposite side, as in drawing lines at the opposite end, the fingers are against the try-square and the thumb against the piece (Figs. 20 and 42).

Fig 19. Lining. Compare this position with that shown in Fig. 42.

Fig. 20. Lining. Reverse position.

See that the line is straight, and that it passes exactly through the center of the mark made by the point of the knife when laying off the spaces. Be sure to keep the head of the try-square against

the edge having the face-mark. Draw a line in a similar manner at each of the points. After the lines have been drawn the marks made by the point of the knife should not be visible. By standing with the left side a little toward the bench one will be more apt to draw the lines correctly. When near the opposite end the try-square and piece should be reversed and the lines drawn as shown in Fig. 20. In drawing lines on a wide piece the try-square is held as shown in Fig. 21. No matter how wide or how narrow the piece, the knife must be held at the same angle the entire length of the line. Any variation in the angle which the knife makes with the surface of the piece is quite certain to cause an irregularity in the line. If you are drawing lines on a piece which is too long to be re-

Fig. 21. Lining on a Wide Piece.

Fig. 22. Lining at the Left-Hand End.

versed you may draw the lines at the left-hand end, as shown in Fig. 22.

Fig. 23. Testing Lines.

After completing these lines, go back over each line with the try-square and examine them very carefully to see if they are exactly straight across. Hold the piece up to the light, as shown in Fig. 23. Place the rule on edge on the piece and see whether the lines coincide with the inch lines on the rule. If they do not appear to be square, or at the proper distances, go over them again with the knife and correct them.

Next lay off $\frac{1}{2}$ inches, and draw lines through these points from the line which is 1 inch from the edge to the face edge. When these are completed and corrected, lay off $\frac{1}{4}$ inches, and draw lines from the line which is $\frac{1}{2}$ inch from the edge to the face edge. Next lay off $\frac{1}{8}$ inches, and draw lines to the remaining gauge line. Be careful to make full, even lines, holding the knife well on the point. Should these lines not be neatly and accurately drawn, draw similar gauge lines on the opposite side, and repeat the knife lines as on the first side.

Continue to practice laying off spaces and drawing lines until you can make every line correctly.

It is useless to attempt to make joints or construct any of the models until you have learned to lay off spaces and draw lines correctly. If necessary, plane off the lines and try again. Make a gauge line to plane to, and plane the side to correct shape before attempting to repeat the lining.

LESSON VII

Bench-Hook

Select a piece of stock of poor quality (sap or small knots) $\frac{7}{8}$ of an inch thick, 4 inches wide, and 12 inches long. Dress it with the plane on all four sides, planing it out of wind, the edges square, and

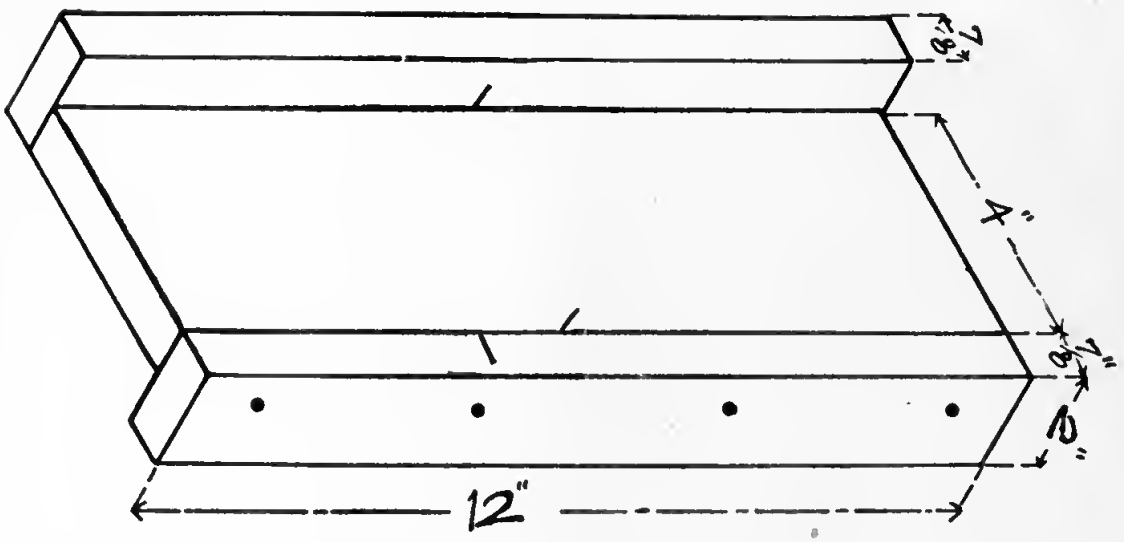


Fig. 24. A Plain Bench-Hook.

the ends of equal width and thickness.

Select two more pieces of the same length and thickness, and each 2 inches wide. Make these also smooth, straight, out of wind, and their sides and

edges parallel. Follow the same method in working these three pieces as in dressing up the first piece.

Fig. 25. Starting a Nail. Examine the nail from two positions as in boring (Figs. 35 and 36).

Nail the pieces together as shown in Fig. 24, using six-penny box wire nails. Lay one of the narrow pieces on the bench and start a nail as shown in Fig. 25. After the nail has been driven into the piece a very short distance, examine it from two directions to see if it is perpendicular to the surface of the piece. If not, move it with the hand until it is. After placing it in correct position, hit it a light blow with the hammer and examine it again. Continue to drive it a little at a time, examining it after each blow until you are certain it is entering the wood properly. Be careful to hold the hammer as

shown in Fig. 25, and drive this nail until it just pricks through the piece. See if the nail is properly located to enter the center of the edge of the wide piece, and not so near the end as to split the piece. Start three more nails in the same manner, being careful to locate them correctly (Fig. 24). After the four nails are properly started, place the piece containing them on the edge of the wide piece and adjust it so that the edge of the narrow piece will be even with the surface of the wide piece (Fig. 26). The points of the nails will help to keep the piece in place while you take the hammer and drive the first nail into the wide piece. If the nails were driven through too far in starting, turn the piece over and drive them back until they will just scratch the edge of the wide piece.

Fig. 26. Driving a Nail.

Fig. 27. Using a Nailset.

If the piece now appears to be all right, drive the nails in their full length and, with the nailset,

set the heads about $\frac{1}{32}$ of an inch below the surface, as shown in Fig. 27. If no nailset is at hand, the head of a nail may be used as a nailset, as shown in Fig. 28.

Fig. 28, Using a Nail for a Nailset.

In case you wish to withdraw a nail after it is partly driven, use a claw-hammer and block, as shown in Fig. 29.

Fig. 29. Withdrawing a Long Nail.

After the two pieces are nailed to the edges of the wide piece examine them to see if their edges are smooth, or flush, as it is termed, with the surface of the wide piece. If the joints are not flush, plane them down as shown in Fig. 30.

As the bench-hook is to be used as a cutting board and for sawing, etc., it is not necessary to smooth the ends. When it is all completed, look it over carefully to see how well the

Fig. 30. Planing a Joint Flush.

pieces fit each other, and whether they appear to have been well planed. Supplementary Lesson No. 29 is a bench-hook of a more difficult design, which may be made in place of this one.

Fig. 31. Jointing an Edge of a Thin Piece. Use the vise only when the piece is too thin to hold against the stop. Except for very light planing you should stand more at the end of the piece than the young man in this picture. Compare this position with that shown in Fig. 1.

LESSON VIII

Shelf Border

The stock for this exercise should be of good quality straight-grained pine. It should be $17\frac{1}{2}$ inches long, $3\frac{1}{4}$ inches wide, and $\frac{9}{16}$ inch thick. Dress up the best side and best edge, as in Lessons 1 and 2, except that in jointing the edge you should place the piece in the vise, as shown in Fig. 31. Gauge to 3 inches wide and finish the second edge. Gauge to $\frac{1}{2}$ inch thick and finish the back, or second side.

Lay off on the back, or second side, $\frac{1}{2}$ inch spaces, leaving about $\frac{1}{4}$ inch of waste at each end. Draw

lines with knife and try-square across the piece through each of these marks, as shown in Figs. 19 and 20. Test the lines carefully, as shown in Fig. 23.

Fig. 32. Lining on an Edge. Notice that the workman stands erect with the hands in an easy position. Compare the position of the try-square with that shown in Fig. 33.

Set the gauge to $2\frac{1}{2}$ inches and draw a line on the second, or back side. This line should be just $\frac{1}{2}$ inch from the second, or back edge, and, if the piece is under size, set the gauge enough less than $2\frac{1}{2}$ inches to make the line just $\frac{1}{2}$ inch from the back edge. Do not set the gauge to $\frac{1}{2}$ inch and gauge from the back edge, but set the gauge so that when the block is against the face edge the spur will make a line just $\frac{1}{2}$ inch from the back edge. If you have a lead pencil point in

your gauge (as shown in Fig. 154), use it instead of the spur in drawing this line. Draw gauge lines on each edge $\frac{1}{8}$ inch from the face side.

Fig. 33. Lining on an Edge. Reverse Position.

With the knife and try-square draw lines on each edge from the ends of the lines which are on the back side across the edge to the gauge line which is $\frac{1}{8}$ inch from the face side. Be careful to have the lines meet exactly at the edge. The piece may be held in the vise while drawing the lines on the edges, as shown in Figs. 32 and 33. To set the try-square for drawing the lines on the edges, catch the point of the blade in the end of the line on the side and move the try-square up to the blade, as in lining around the rule (Fig. 42).

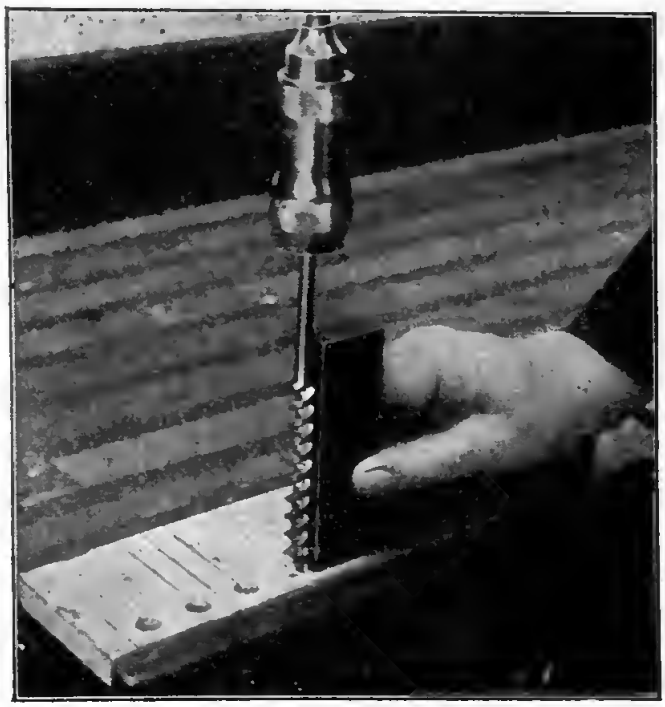


Fig. 34. Try-Square at the Side of the Bit

LESSON IX

Boring

Select the $\frac{7}{16}$ inch bit and put it in place in the bit brace. Place the shelf border in the vise and make an X on every second line where the lines cross the line which is $\frac{1}{2}$ inch from the back edge, beginning with the third line from the ends. There should be sixteen marks.

Fig. 35. Boring.

Place the spur of the bit at the points indicated by the marks exactly where the knife lines cross the gauge line (Fig. 71). Raise the brace to a position at right angles to the surface of the piece. These angles may be tested with the try-square (as in Fig. 34); but it is better to stand first in front of

the piece as shown in Fig. 35, to be sure that the bit is at right angles as seen from this side, and then step to the end of the piece as shown in Fig. 36, still holding the brace in the same position, and see whether it is correct as examined from the end. A little practice in this manner will make it possible to bore holes at right angles to the surface without the use of the try-square. Do not make the mistake of attempting to examine the bit and brace from

Fig. 36. Boring. Compare this position with that shown in Fig. 35.

more than the two positions. As it is often quite difficult to apply the try-square, and as it consumes more time, it is far better to learn to do without it.

When you are quite certain that the bit is in correct position, turn the brace slowly, being careful that the upper end of the brace does not move sidewise. If the bit is a good make and properly sharpened, it will cut without any pressure on the knob. One hand should keep the brace perpendicular and the other hand revolve it. It is not important which hand is on the knob, or which on the sweep, for often, when many holes are to be bored, you will change hands in order to rest them. As soon as the spur can be felt at the other side, remove the bit and bore the next hole. Continue in this manner until all the holes have been bored from one side. Then place the piece in the vise, face side up, and finish the holes by placing the spur of the bit in the hole made while boring from the other side. Do not think that you need not be careful in boring from this side, for if the brace is not perpendicular to the surface, you will be likely to split off some of the edge of the hole on the back side. It is to avoid this roughness that you bore from both sides.

If the board has a tendency to split it should be moved in the vise, so that the pressure of the vise will tend to keep it from splitting.

LESSON X

Sawing

Fig. 37. Using the Backsaw.

Place the shelf border on the bench-hook and take the position for sawing shown in Fig. 37. In starting the cut, guide the saw by holding the side of the finger or thumb-nail against the side of the saw just above the teeth. It is best to begin by moving the saw forward and backward the full length, resting it against the thumb or finger, but not allowing it to touch the piece. Next

lower it so that it will touch the back corner a very little, and continue moving it forward and backward, but do not allow it to cut. After you are sure that you have the correct motion, allow it to cut a very little, gradually lowering the hand and cutting farther across until the kerf extends entirely across the surface. Do not rest the saw full weight on the board while it shows any tendency to catch when making the forward stroke. Fig. 38 indicates the various positions of the saw in starting and gradually lowering the hand until the kerf extends entirely across, when the saw is nearly or quite level. Do not try to start

Fig. 38. Positions in Starting the Saw.

the saw by drawing it toward you and then lifting it on the forward stroke. Learn to control the saw properly, and then there will be no need to draw it backward to start it.

See that the saw cuts very close to the line, but that it does not cut the line. The line should not be broken or roughened by the teeth of the saw. Neither should there be any material between the saw kerf and the knife line. Watch carefully the knife lines down the edges, and continue sawing until the kerf extends to the lines which are $\frac{1}{8}$ inch from the face side. Be very careful to saw exactly to the lines and no farther, for the piece is to be bent; and if the sawing is not well done, the piece may break instead of bend.

You may set a try-square at the side of the saw to see when it is at right angles to the surface (as in Fig. 95), but it is better to accustom the eye to see the correct angle by looking at the corner in which the try-square would be placed. Avoid looking directly down upon the saw. Always look obliquely to the surface of the board. Saw at the same side of each line, except one line at each end, which is to be left until you are ready to smooth the ends. Begin near one end and change ends as you near the opposite end. After cutting all the lines, except the end ones, place the piece in the vise and saw from the edge into each hole.

LESSON XI

Chiseling

Lay the piece for the shelf border on the cutting board and grasp the $\frac{7}{8}$ inch chisel as shown in Fig. 39. Remove a very little of the corner at a time, and move the chisel forward and downward at the same time. The points may be marked off as shown in Fig. 41 in the completed shelf; yet it is probably better not to mark them off, as it is necessary to go over them several times, each time making them a little nearer the correct size and shape until they are all alike and of good proportion. If lines are drawn you will probably try to remove too large a shaving at one time.

If the chisel is properly sharpened and moved downward and forward at the same time, the surface will be cut glossy smooth. Do not be satisfied until this smoothness is attained, as it is to learn to cut smoothly with the chisel that this exercise is given. When the chisel is properly held and used, it requires but very little force to make the cut. If much force is required try to discover what is wrong.

Always hold the chisel perpendicular to the surface of the piece being cut, and with the flat side in line with the arm (Figs. 39 and 40). Always place the flat side of the chisel against the wood, reversing it in the hand as you change from cutting

at one side of the point to the other side. If the points have a tendency to split, or if pieces tend to roll out, it is because the chisel is dull, or because you are not holding it perpendicular to the surface of the board, or not moving it forward enough in proportion to the distance downward. It may be

Fig 39. Using a Chisel.

Fig. 40. Using a Chisel. Reverse Position.

caused by any one of these mistakes or by a combination of two or more of them. In any case, keep trying until it does cut smoothly and squarely. After you have made the points as nearly correct as you can make them by testing them with your eye, test them with the rule and try-square.

When you have all the points finished, lay the piece aside until you have made the shelf.

LESSON XII

Making the Corner Shelf

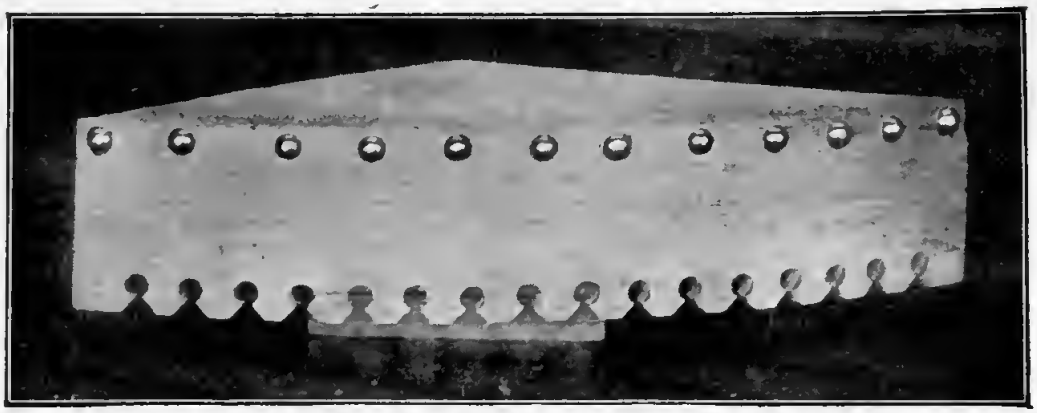
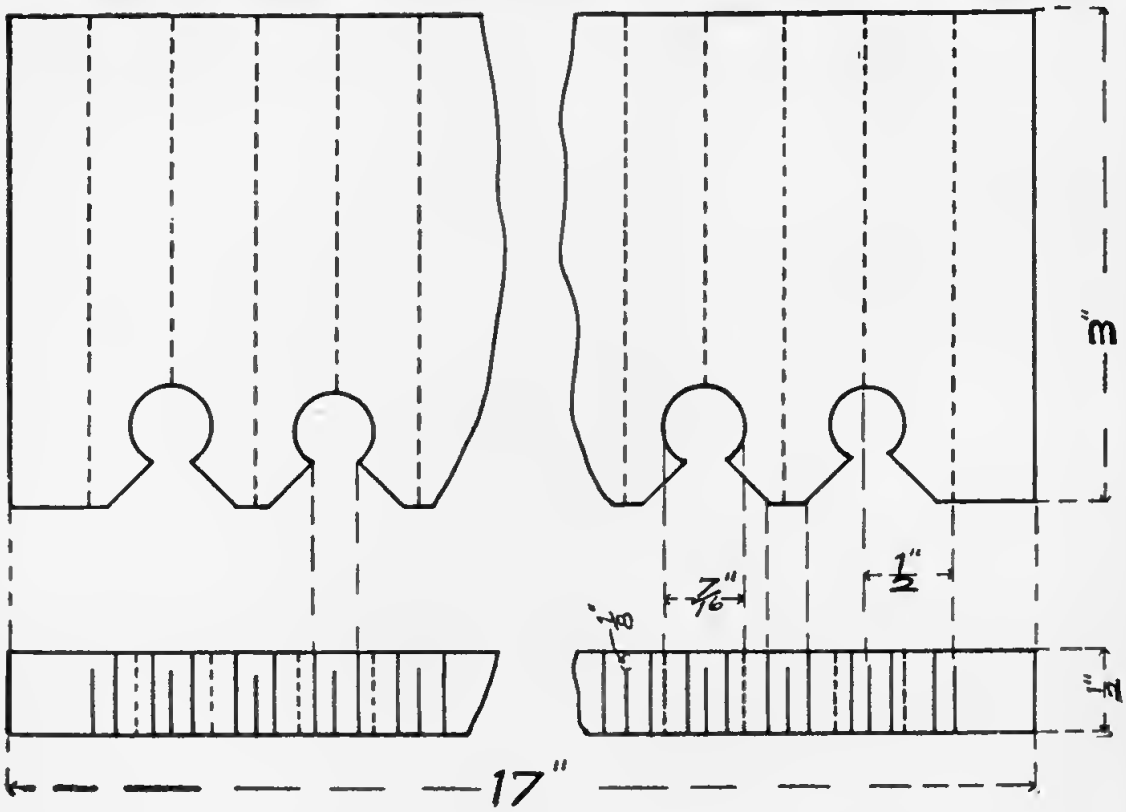


Fig 41. Corner Shelf.



The border completed in Lesson 11 is intended for a corner shelf. The shelf should be similar in shape to the one shown in Fig. 41. If the border does not bend easily the curve may be nearer straight.

Get out a piece of board about $\frac{3}{4}$ inch thick and cut one edge of it to the curve desired. The curve may be drawn freehand and then sawed with the compass saw or with the handsaw and finished with the smooth plane. In planing the edge of the shelf, hold it on edge in the vise. Nail the border to place and cover the nailheads with a thin strip of pine dressed to a half oval, or with fancy-headed nails, such as are shown in Fig. 162 B.

After the border is in place, cut the remaining edges to the desired shape and finish them smoothly with a plane. The shelf may be suspended by using either screw-eyes, cords, or laid upon cleats fastened to the wall.

The entire shelf should be finished with three coats of shellac.

LESSON XIII

Chiseling Ends

Take the piece you lined like a scale or rule in Lesson 6 and draw a line on all four sides at the end of the scale. This line is drawn by placing the point of the knife blade in the end of the line (Fig. 42) and moving the try-square blade up to it, keep-

ing the head of the try-square firmly against the side having a face-mark. After the try-square is in position, draw a line as in making the scale (Figs. 19 and 20). Be very careful to have the knife at the same angle when drawing the line as it was

Fig. 42. Lining Around an End. Compare the position of the try-square and fingers shown in this figure with the positions shown in Figs. 19, 20, 21, 32, and 33.

while setting the try-square; otherwise the lines will not meet exactly. Draw lines on the remaining two sides in a similar manner, and note that the try-square head has to be reversed in order to keep it against a side having a face-mark.

After drawing lines at each end, place the piece on the bench-hook and saw the ends off with the backsaw. This time do not saw close up to the line, but about $\frac{1}{32}$ inch away from it, because the

saw does not leave a smooth surface. After the ends are sawed off, take the chisel in the right hand, as shown in Fig. 43, and smooth the ends. Be particular to use a shearing cut, the same as in chiseling the shelf border (Lesson 11), so that the ends will be cut very smoothly. Cut about halfway across from each side, but do not cut from either edge. Test the ends with the try-square, and if they are not square and smooth draw lines around again, this time about $\frac{1}{32}$ inch from the end, and try again to chisel the ends smooth. Keep trying until the ends are smooth and square, even if the scale is less than 1 foot long. Remember that it is useless to try to chisel the ends properly after you have cut beyond the line made by the knife. When the ends are finished the glossy surface made by the side of the point of the knife blade should be visible entirely around each end.

Fig. 43. Chiseling an End.

LESSON XIV

Sandpapering

Take a sheet of No. $\frac{1}{2}$ flint paper, or sandpaper, as it is commonly called, and lay it, paper side up, on the bench. Place the backsaw across it so that the teeth of the saw will be at the center of the sheet, and tilt the blade to bring the teeth firmly against the paper. With the right hand grasp one corner of the paper and pull upward and toward the saw, tearing the paper across the center as shown in Fig. 44. Tear one of these pieces again, making a piece $\frac{1}{4}$ the size of the sheet. Tear a sheet of No. $1\frac{1}{2}$ paper in the same manner.

Fig. 44. Tearing Sandpaper.

Place the half sheet of No. $1\frac{1}{2}$ paper on the bench with the flint side up. Hold the scale com-

Fig 45. Sandpapering an End.

pleted in the last lesson as shown in Fig. 45. Hold it very firmly, and move it from you without allowing it to shake or tip. Notice that the thumb and fingers are as near the paper as they can be without being injured. Examine the end of the piece often, using a try-square, and each time change the position of the piece, so that it will be smoothed and yet kept straight and square. When all the roughness left by the chisel has been removed, repeat the operation, using the half sheet of No. $\frac{1}{2}$ paper. Continue using this paper until the surface appears bright and the grain of the wood shows plainly. The coarse paper is to remove the tool marks, and the finer paper is to remove the fine white torn grain and scratches made by the coarse paper. You will notice that it is possible to remove only small irregularities with the coarse paper, for if we try to remove any large defects the corners will become rounded, and it will be necessary to reline and rechisel the end. In no case leave the corners rounded, for round corners are the mark of the shiftless workman.

When each end has been properly smoothed, take a quarter sheet of the No. $\frac{1}{2}$ paper and fold it carefully to $\frac{1}{8}$ sheet size. Hold it as shown in Figs. 46 and 47, and smooth the four sides. Do not use a block for work of this kind, as it would surely round the corners and spoil the work. Be very careful not to rub much near the ends or edges.

Remember that the paper cuts most directly under the fingers, and therefore be careful how you press upon the paper, and frequently change the position of the fingers, so that the paper will be worn evenly. Do no more rubbing than is necessary to make a smooth, glossy surface. Too much sandpapering is as bad as too little. By holding the work up to the light you can easily distinguish the smooth from the rough places. Learn also to test the work by feeling with the hand or fingers.

Fig. 46. Sandpapering a Side. Compare this view with Fig. 47.

Look closely at your work, and you will discover that it is best to rub lengthwise of the grain. Scratches made by rubbing across the grain are quite apt to injure

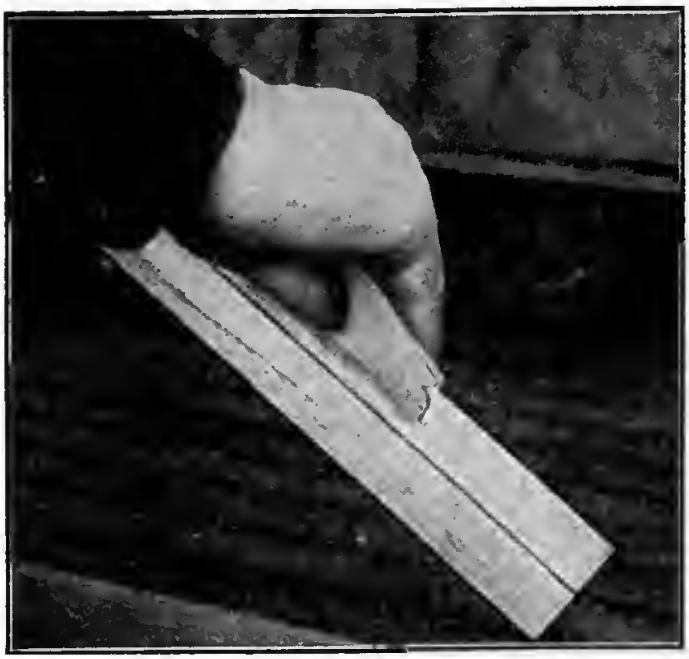


Fig. 47. Sandpapering. Observe that the paper does not touch the edge of the piece.

the appearance of the finish. It is necessary to rub both with the grain and against the grain in order to remove the fine fibers which stick up on the surface.

LESSON XV

Shellacing

Fig. 48. Shellacing.

See that you have not forgotten to write your name and date on the piece. Wipe the dust from the piece and drive a small nail or brad into one end by which to hold it.

See that the shellac is not too thick. Fill the brush, and wipe the excess off by drawing the end of the brush over the wire placed across the dish for this purpose. Shellac the ends first, next the edges, and

lastly the sides. Do not draw the brush against the corners, as it will cause the shellac to pile up there. When the shellac is dry, this excess will show plainly and is not easily removed. It is a good rule to brush from the center outward. When applying the shellac, hold the piece so that you see the light reflected from the surface, as this is the only position in which you can see exactly what you are accomplishing (Fig. 48).

When you have gone over the piece, stand or lean it up to dry. Do not go over the surface in places

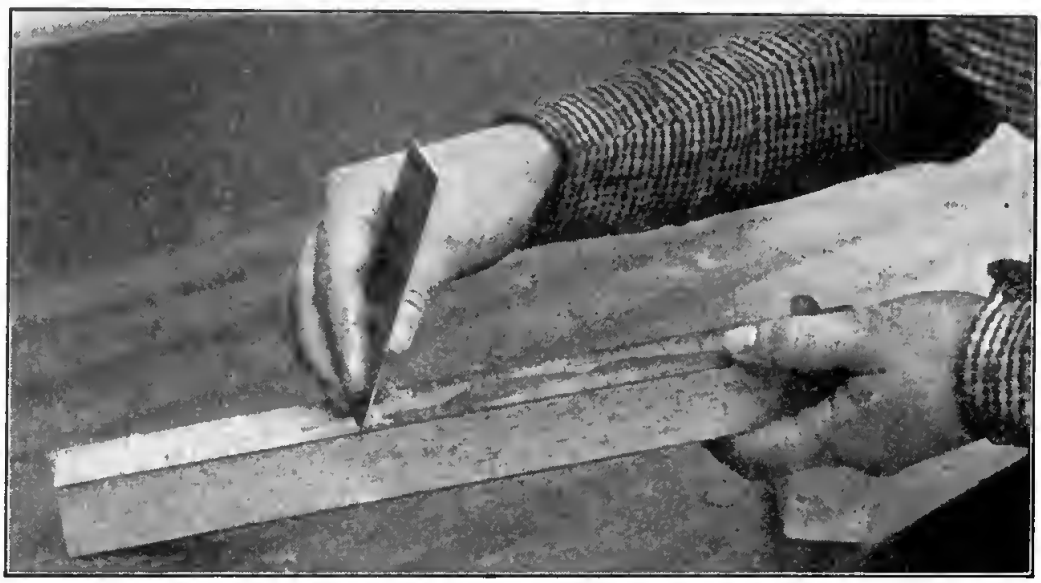


Fig. 49. Scraping Thick Places in the Finish.

more than once. Some spots will absorb the finish very rapidly and others very slowly. To get a good finish the first coat of shellac should be laid on evenly and allowed to dry thoroughly before more is added.

After the piece has dried for one or more days, smooth it to a nice glossy surface with No. $\frac{1}{2}$ sand-

paper. At the corners or other places where, by mistake, the finish is very thick, use the scraper as shown in Fig. 49. Hold the scraper as near vertical as it will cut. There is great danger of scraping or rubbing too much and thus spoiling the finish. The most common mistake is to rub at the corners or at a small spot in the center until it shows white. By keeping a constant watch, and often changing the position of the fingers on the paper, this may be avoided. When the piece is ready for the second coat of finish it will feel smooth and glossy to the touch and will present a dead smooth surface when held up to reflect the light.

Apply the second coat the same as the first one, except that it may be somewhat thinner and must be applied with more care, more evenly, and much more quickly. Several more coats of finish may be applied in the same manner.

LESSON XVI

Halved Corner

The stock for this exercise should be of pine or other soft wood. It should be $12\frac{1}{2}$ inches long, $1\frac{3}{4}$ inches wide, and $1\frac{3}{8}$ inches thick. Dress up the piece on all four sides in the same manner, and

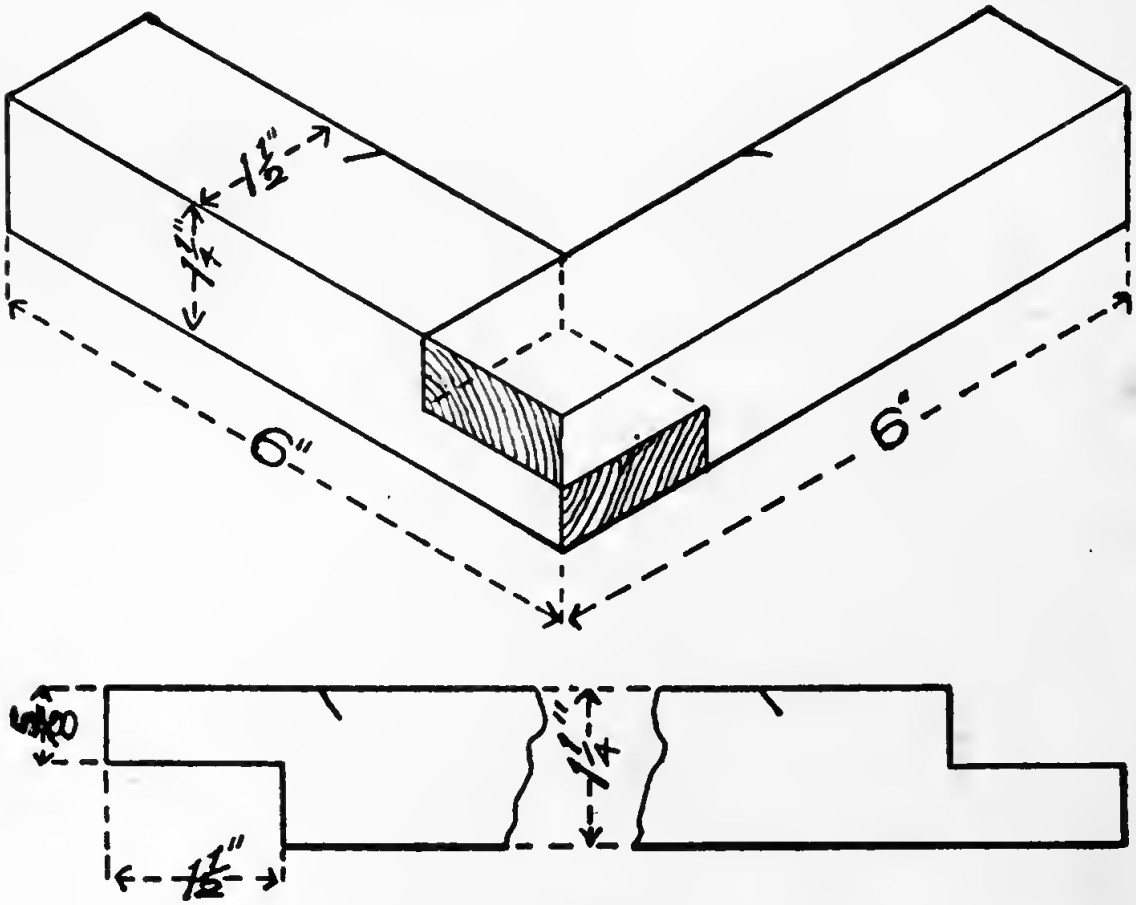


Fig. 50. Halved Corner.

follow the same order that you did in planing the first piece or scale. Remember what is said in Lesson 4 about setting the gauge so that you may plane off the line and yet have the piece full size.

We wish to have this piece of correct size, and straight to the very ends. The face side and face edge must be plainly marked as directed in Lessons 1 and 2 and shown in Fig. 11. This piece requires two sets of face-marks because it is to be cut in two.

Fig. 51. Drawing Lines Across an End.

Study the drawing (Fig. 50) until you understand thoroughly what is to be made. Lay out the piece as indicated by the drawing, using the try-square and knife to make the lines at right angles to the edges, and the gauge to make the lines parallel with the edges. Do not forget that the gauge lines must be drawn with the head of the gauge against one of the surfaces which has a face-mark. In changing from one side to the other side you should revolve the piece end for end in order

Fig. 52 Splitting out Waste Material. Do not use this method until you have learned to work as shown in Figs. 53A and 53B.

to bring, or rather to keep, the face-mark at the right side, so that the head of the gauge will be against the face-mark as the gauge is held in the right hand.

The reason for always working from face-marks may not be understood by the pupil while making these first exercises, but it must be carefully attended to or later on much work will be spoiled. Draw gauge lines not only at the sides but also at the ends, holding the gauge and piece as shown in Fig. 51. Be careful not to draw lines beyond where the wood is to be removed, for if you do they will show on the finished work. Set the gauge to the exact distance

when you are drawing lines for making joints and the like. The directions for setting the gauge a little large, so that the entire line may be planed off, apply only to lines drawn for the sizing of the piece. After the knife lines and guage lines are all drawn, examine the piece thoroughly to see if all are correct. If any mistakes are found, correct them at once. Mark the parts to be cut away at each end with a large X so that you will not make a mistake and cut from the wrong side. In this case, one mark will be on the upper, or face, side and the other mark on the lower, or back, side of the piece.

Fig. 53A. Chiseling at the Right Hand End.

Fig. 53B. Chiseling at the Left Hand End.

Lay the piece on the bench-hook, and with the backsaw saw just enough to one side of the line to allow for smooth-

ing the end grain with the chisel, as in smoothing the end of the scale in Lesson 13. Saw each end, remembering to turn the piece over in sawing the second end. Be very careful to stop exactly at the gauge line.

With the piece on the bench-hook and the chisel in hand, as shown in Fig. 53 A, remove the waste material a very little at a time. After you have

Fig. 54. Testing a Gain with a Chisel.

become skilled in using the tools you may place the piece on edge and remove a large piece at once by using the chisel and mallet as shown in Fig. 52, but for the first exercises it is best to do the work without a mallet and cut as thin and smooth shavings as you can. Instead of trying to do the work

quickly, see how many and how wide and how thin shavings you can make. To begin this way will result in your doing more and better work in the future. By holding the chisel at a slant, so that one corner cuts ahead of the other, it will cut more easily and more smoothly. The way of the grain will

Fig. 55. Testing a Gain with a Try-Square. The head of the try-square is not held against the piece.

determine which corner is to cut ahead. Examine the pictures carefully and hold your tools in the same manner. Never place your fingers or hand where the chisel might injure them if it should slip, or the piece split.

Slant the chisel so that it will be farther from the line on the back side than on the front side. Continue to work the notch down until the chisel is almost to the gauge line, then place the chisel exactly and squarely in the line and make a careful cut, finishing the gain at this point. When you have cut to the line at this edge, reverse the piece, holding it and the chisel as shown in Fig. 53 B, and cut to the line on this edge. It is not necessary to work much of the gain from this side. Do not use the vise for holding the piece. If you were a skilled mechanic you would not take the time to use the vise, and for the unskilled workman to use the vise is to lose the opportunity to learn that which the exercise is intended to teach.

Fig. 56. Testing a Gain with a Try-Square. The head of the try-square is held against the face edge

Handle the tools with as little force as possible, for if they are properly used not much force is required. Use the chisel or blade of the try-square to test the gain, as shown in Figs. 54, 55, and 56. After each end has been properly finished, draw two

lines around the center of the piece about $\frac{3}{32}$ of an inch apart and saw between them. Try the pieces together, placing the face-marks at the inside, as shown in the drawing (Fig. 50). Place the try-square at the inside angle to see if the pieces make a right angle as shown in Fig. 57, except that in testing the joint before it is glued you will lay it and the try-square upon the bench. See that the joint fits tightly at all places. If the joint is not right, do not try to make it fit by cut-and-try methods, but find out what place is wrong and then reline it and work exactly to the line. Continue testing and relining until the fit is correct.

Fig. 57. Testing the Joint. Before the piece has been glued the joint should be placed on the bench and the try-square applied as indicated in this figure.

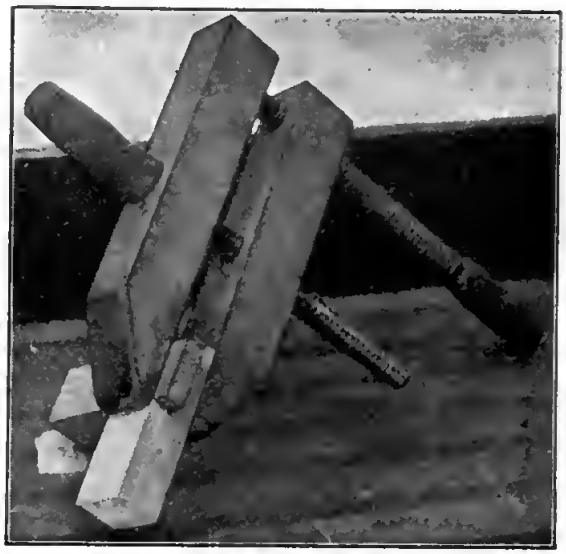


Fig. 58. Halved Corner Clamped.

When the joint is finished put a little glue on the surfaces which come in contact. Allow the

glue to dry until it will string out like cobwebs when touched with the finger. Then place the pieces together, being very careful to keep them in correct position, and put a clamp on them to hold them in place until the glue has dried (Fig. 58). Be careful that the clamp does not cause the pieces to slip apart. Always place the clamp on work so that the joint may be examined after the clamp has been tightened. (Read what is said about clamps in Part 3.)

LESSON XVII

Finishing the Halved Corner

After the glue has properly set, which will require several hours, remove the clamp. Take off any surplus glue with a chisel, being careful not to roughen the surface of the wood. The pieces should be smooth at the sides where they join, but if they are not, plane down the side having a face mark until it is even, or flush, with the other face surface. Considerable care is required to avoid working the piece tapering or small at the outer end. Also avoid planing too much at the outer edge. Apply a straight edge or the try-square blade as shown in Figs. 59 and 60. Move the try-square over the entire surface and be very particular to have the plane cut at the proper place. In order to have the plane cut properly it is frequently necessary to take a shaving first from one of the pieces

and then from the other, changing from one to the other at every stroke of the plane. When this side is correct, set the gauge to the thinnest corner and gauge around the piece to determine how much

Fig. 59. First Test After Gluing.

is to be taken from the opposite, or back, side. Test this side the same as the first side, in addition to planing to the gauge lines.

After the sides are finished, place the piece in the vise as shown in Fig. 61, and plane the rough

ends down even with the edge of the piece. Should the stub ends project more than $\frac{1}{8}$ inch, line them with a knife and saw them to within $\frac{1}{32}$ of an inch of the face of the other piece. Finish the

Fig. 60. Second Test After Gluing.

other end in the same manner. Measure the pieces at the ends and near the corner to determine if they are the same size at each end. If they are not, plane them until they are. Also test them by applying the head of the square to the face side and the blade along the outside edges. Also apply

the square as shown in Figs. 57 and 62. All of these

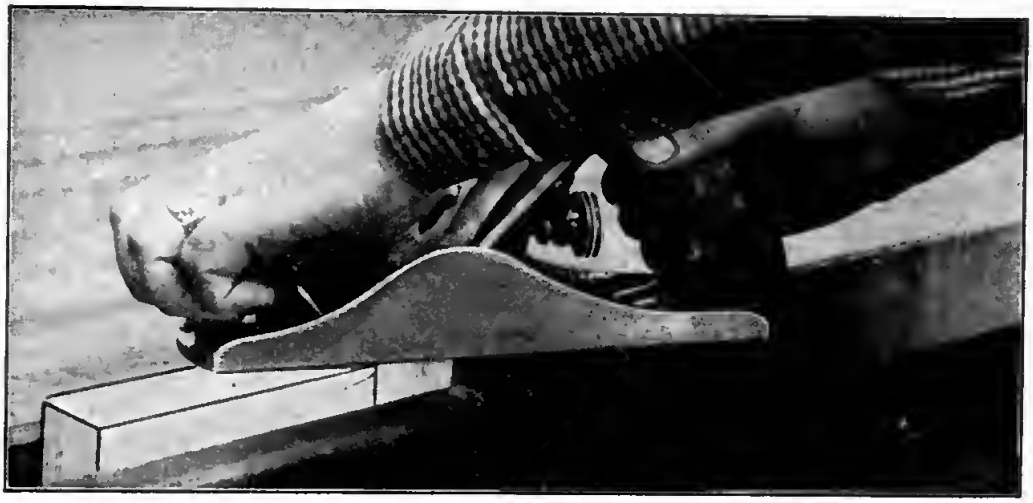


Fig. 61. Planing in the Vise.

tests are required to determine whether the piece is correct. When the sides and edges are completed, line around them with knife and try-square, making them 6 inches long at the outside edge. Saw and chisel these ends the same as you did the ends of the first piece.

Fig. 62. Testing the Outside of the Corner.

Finish this joint with sandpaper and apply two coats of shellac. The ends should be held in the same manner as the ends of the rule in Lesson 14 (Fig. 45). The end grain at the corners may be sanded as shown in Fig. 63, but the outer edges should be finished by holding the paper as shown in Figs. 46

and 47. In sanding, where two pieces join with their grain running at right angles, as on the surfaces at the corners, sand the piece first which necessitates the paper passing over and scratching the other piece. Then sand the other piece, working carefully up to the end of the first piece with the folded edge of the sandpaper. This will finish the joint without leaving any marks from the paper on either piece. To smooth the edges at the inside of the corner, fold the sandpaper at a fresh place and press it closely into the corner. A scraper is sometimes of assistance in finishing in corners. Be very careful not to round the ends or edges.

Fig. 63. Sandpapering at the Corner. The end grain only is sanded in this manner.

LESSON XVIII

Making a Halved Tee

The stock for this exercise should be the same as for the halved corner (Lesson 16).

Reduce the piece to the exact width and thickness. Leave the ends rough. Lay off the halved end by following the drawing in the same manner

as you laid off the left-hand end of the halved corner (Lesson 16, Fig. 50). Remember to make all gauge lines with the head of the gauge against the face side. Cut the piece in two by drawing

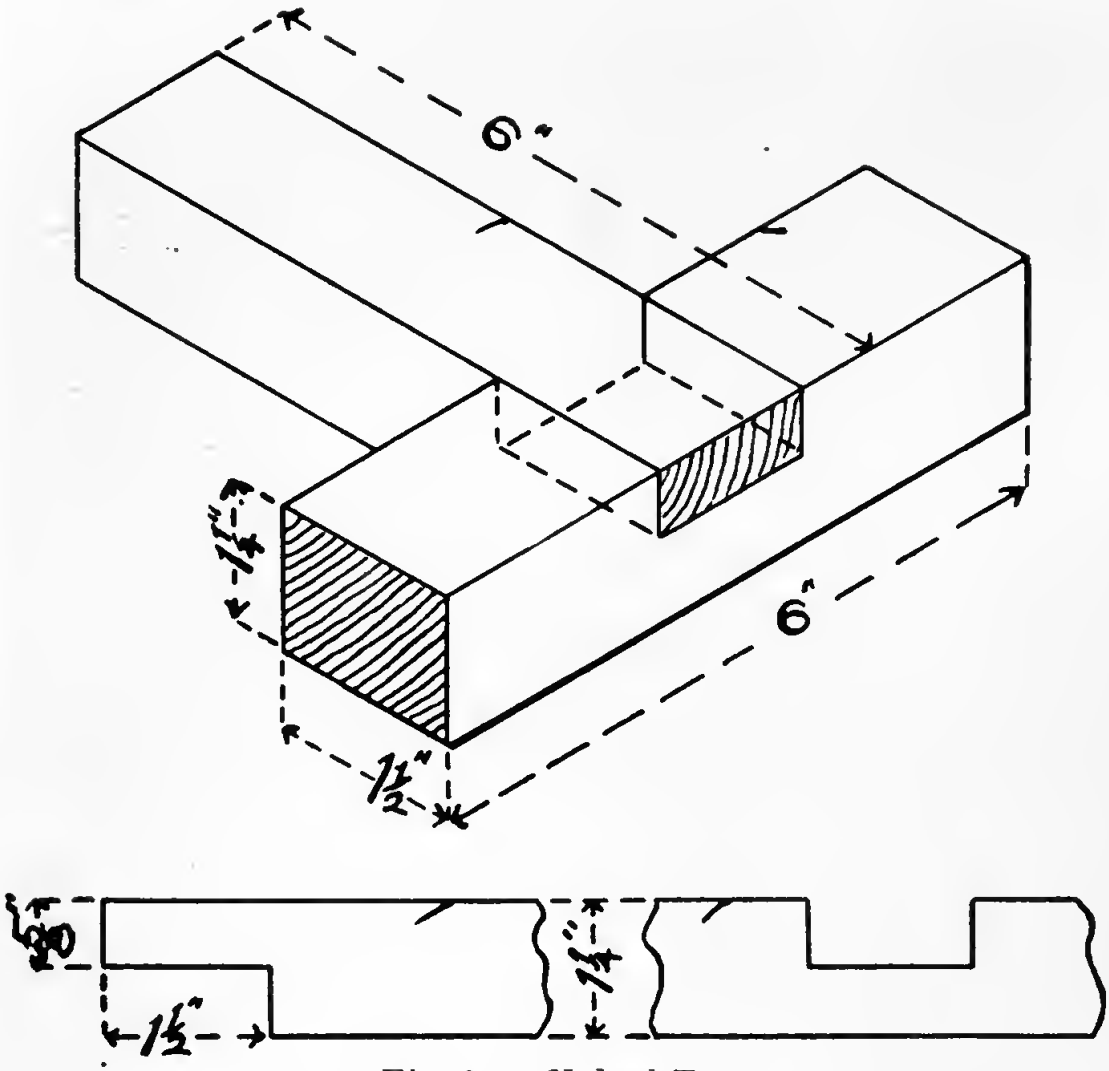


Fig 64. Halved Tee.

two lines entirely around it near the center and sawing between them, as in Lesson 16. Draw one of the lines for the side of the gain with the try-square and knife. Place the end which is to fill the gain or notch onto the piece which is to be cut

out and mark the width of the gain with the knife, as shown in Fig. 65. Remove the piece and draw a line with the knife and try-square just inside of the point made in marking the width. As the piece must fit the gain exactly, a line drawn at the side of the piece or through the mark made by the knife point would make the gain the width of the line too wide. This method of determining the width of a gain or similar opening is called "superposition." Make your lines exactly correct, and work exactly to them. Make smooth fine lines both with the knife and the gauge.

Fig. 65. Getting the Width by Superposition.

Saw just enough inside the lines to allow for finishing the sides of the gain with the chisel. Do not think that because the sides of the gain will not show when the piece is together, that it does not matter how the end grain at the sides of the

Fig. 66. Making a Shearing Cut in a Gain.

gain is cut. All such places should be cut very smooth, using the shearing cut the same as in smoothing the ends in Lesson 13, Fig. 43. Work the bottom of the gain the same as the halved corner. Use a shearing cut as much as you can, and hold the piece as shown in Fig. 66.

This piece should fit close enough to stay together without gluing. Dress off the end of the piece at the gain, or joint, with the plane, holding the plane at an angle of 45 degrees but moving it directly parallel with the edge (Fig. 61). Line and chisel the ends the same as the halved corner (Lesson 17), but do not plane the sides or use any sandpaper on either the ends or sides of this piece

Write your name and the date on the face side near one end.

LESSON XIX

Halved Cross

Stock $1\frac{3}{8}$ inches thick, $1\frac{3}{4}$ inches wide, $8\frac{1}{2}$ inches long, of pine or basswood.

This piece should be worked to exactly $1\frac{1}{2}$ inches by $1\frac{1}{4}$ inches. As each half is to fit into a gain, it is very essential that the piece be made exactly square and exactly the same size at each end. You should now be able to work your material to size and square with little difficuity. Place two sets of face-marks on the piece so that you can

find the face edge after the piece has been cut in two Unless you are very careful you will make the mistake of cutting both notches or gains from

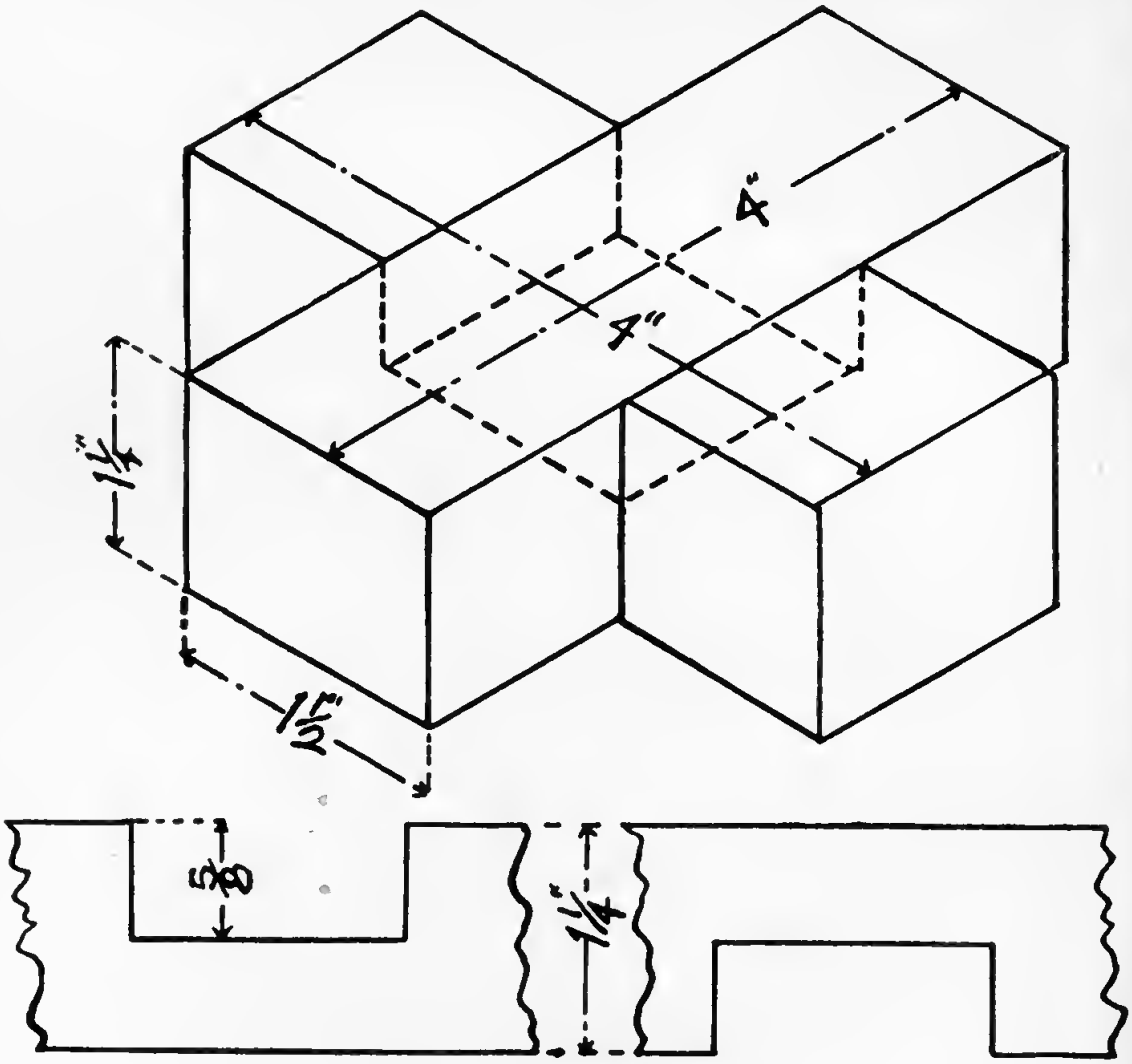


Fig. 67. Halved Cross.

the same side, so that when the pieces are placed together the face-marks will not both be on the same side, as they ought to be.

Lay off the two pieces by superposition as described in Lesson 18. Work the gains in the same manner as the gain in the halved tee (Lesson

18). Finish one piece all ready to be placed together, and then finish the other piece, doing all the work before the pieces are tried together in any way after the lines have been made.

When both are completed, put them together; and if you have done your work properly, they will slip together without the aid of a hammer, and will also be tight at every point. Finish the ends with the chisel, making the pieces each 4 inches long. Do not plane the sides or use any sandpaper on this joint.

LESSON XX

Halved Dovetail

Stock and finished sizes for this piece are the same as for the halved cross (Lesson 19).

Set the gauge and draw the gauge lines the same as in making the halved tee (Lesson 18). Lay out

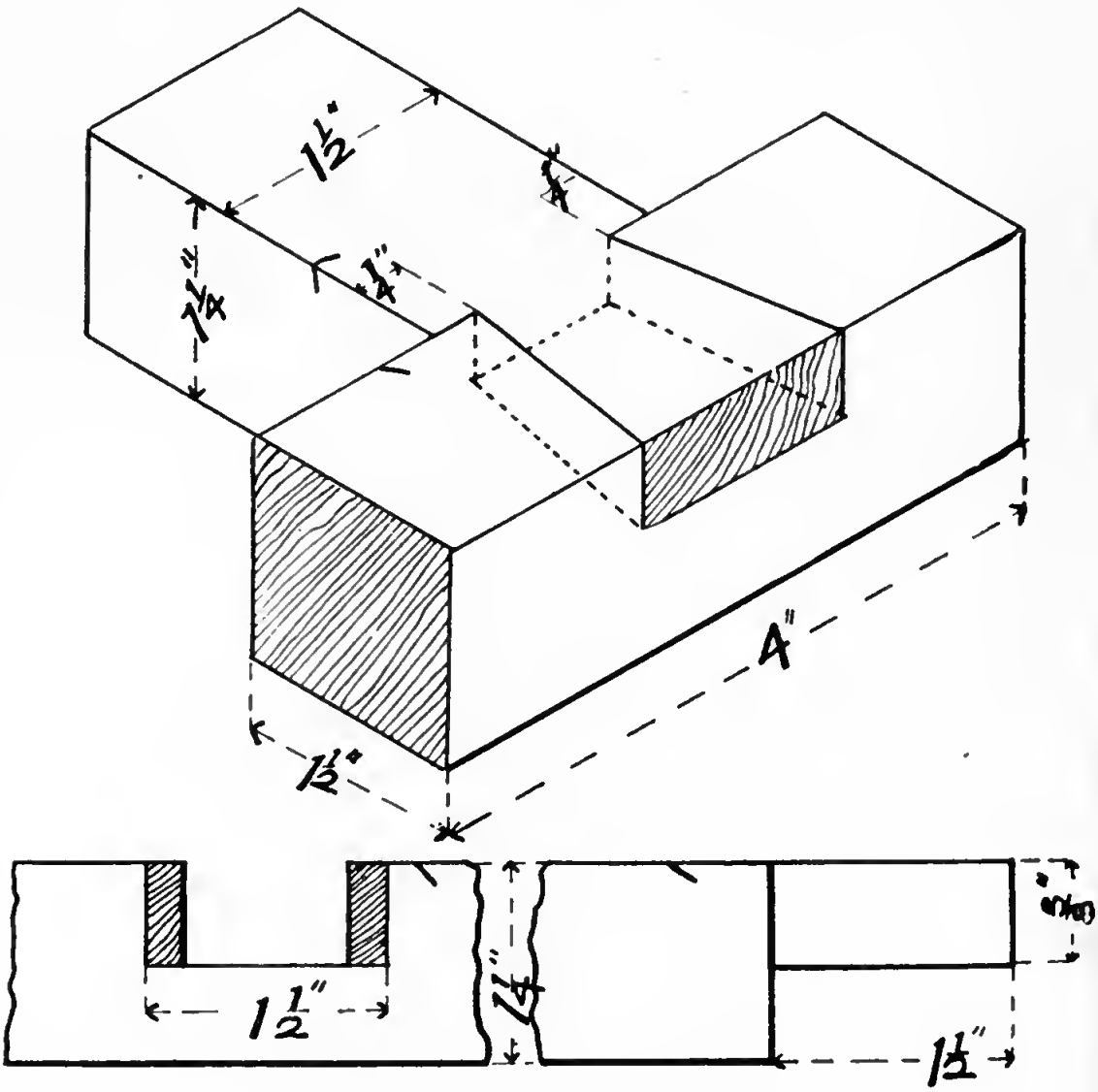


Fig. 68. Halved Dovetail.

the dovetail by drawing 2 oblique lines on the face side with the knife and try-square. Use the try-

square blade as a straight edge in drawing the oblique lines. Draw knife lines across the back side, across each edge, and on the face side from the edges to the oblique lines. First remove the waste material at the back of the dovetail, leaving the end the same as the left-hand end of the halved corner (Lesson 16). Next saw in from the edges to the oblique lines and remove the triangular piece with a chisel. Hold the piece in the vise and work from the end, as shown in Fig. 69. It is very essential that the sides of the dovetail be exactly square with the surface, and the try-square should be used on these sides very carefully, the piece being removed from the vise each time in order to look toward the light.

Fig. 69. Working a Dovetail in a Vise.

After completing the dovetail and testing it carefully, place it in position on the face side of the other piece. Mark very fine lines indicating where the piece is to be cut out to receive the dovetail. Remove the dovetail and, with the try-square blade used as a straight edge, draw lines just inside of the fine lines. Draw lines from the ends of these lines down to the gauge lines on each side. Saw and chisel the opening for the dovetail the same

as in working the gain for the tee (Lesson 18, Figs. 54 and 66).

This joint must fit together sufficiently close to require no gluing. The end of the dovetail may be finished with the plane the same as the halved corner (Lesson 17, Fig. 61). The ends are to be finished by sawing with the backsaw close up to the knife line. The ends are finished in this manner in order to give practice in sawing exactly to a line, as in Lesson 10. If you are unable to saw the ends neatly, practice on a piece of waste material of a similar size. Do no sawing except when you have correct knife lines drawn entirely around the piece. If the sawing is well done the piece will fit closely to another piece when placed against it, and yet the knife line will be visible around the end. Joints are often made entirely by sawing, no smoothing being done with chisel, plane, or other edge tool. Do not plane the sides or use any sandpaper on this joint.

LESSON XXI

Slip Mortise and Tenon

Stock and finished sizes are the same as for the halved cross (Lesson 19).

Lay off and work each end as indicated by the drawing (Fig. 70) before cutting the piece in two. First set the gauge to $\frac{3}{8}$ inch and draw the lines for the side of the mortise, and also the lines for the

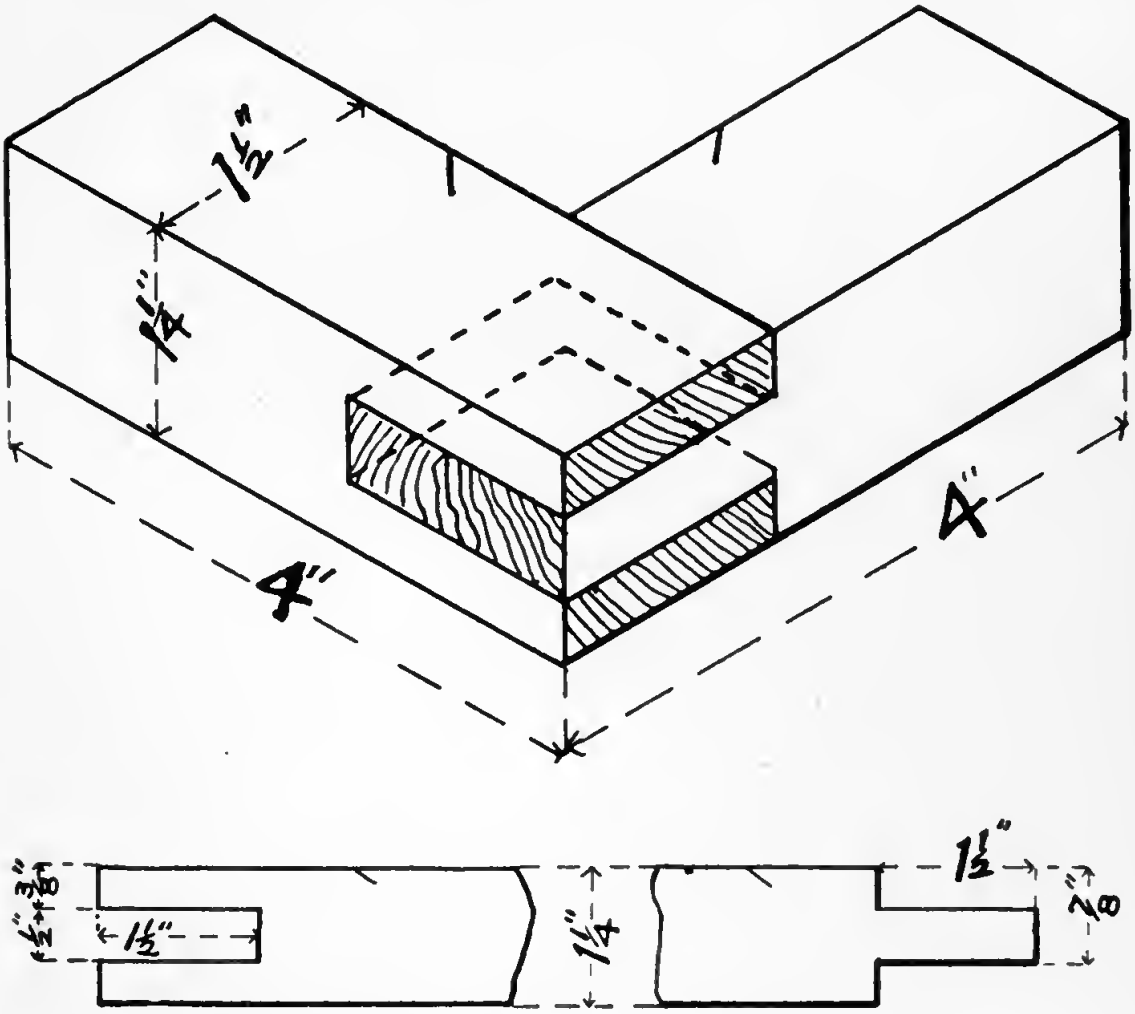


Fig. 70. Slip Mortise and Tenon.

side of the tenon which is next the face side. Draw lines across the ends as well as at the sides. Set the gauge to $\frac{7}{8}$ inch and draw the lines for the

Fig. 71. Setting a Bit to Bore a Hole.

other side of the tenon and mortise. Measure $1\frac{9}{16}$ inches from each end and draw the lines for the ends of the tenon and mortise, using a knife and try-square. In drawing the lines for the tenon

do not draw across the tenon. In drawing the lines for the inside end of the mortise begin at one edge, drawing a line $\frac{1}{2}$ inch long between the gauge lines, and also make a mark at the corner to set the square by in carrying the line around to the other side. Set the square to this mark, and make a similar mark at the opposite corner. Set the square to this mark, and draw the $\frac{1}{2}$ inch line at the end of the mortise.

Fig. 72. Ripping Out Waste Material.

With the $\frac{7}{16}$-inch bit, bore a hole at the inside end of the mortise, boring half way through from each side (see Figs. 71, 35, and 36), and review what is said about boring in Lesson 9. Set

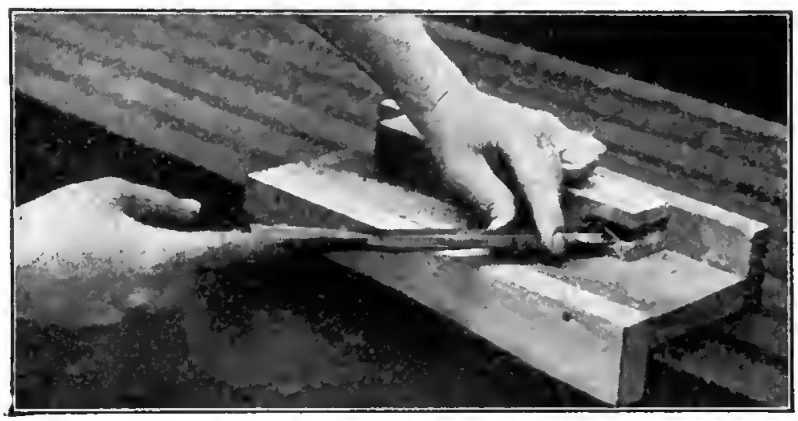


Fig. 73. Finishing the Sides of the Mortise. Compare this figure with the next one.

the piece in the vise at an angle and, with the ripsaw, saw down on the inside of the lines, leaving a small amount of material to smooth with the chisel.

Fig. 74. Finishing the Mortise.

The piece should be so slanted that you begin the cut on the side next to you, and when the saw has cut entirely across the end reverse the piece and saw the other side (Fig. 72). By using this method it is not necessary to watch the line at the back side. Continue to reverse the piece as often as is necessary to avoid cutting any on the side away from you. The tenon may be sawed in the same manner. Lay the piece on the bench-hook and smooth to the center of the lines, as shown in Figs. 73, 66, 53 A, and 53 B. Be very careful not to go beyond the center of the lines, for if you do, the joint will be loose. Use a narrow chisel in testing the sides, as in Fig. 75. To finish the inside end of the mortise use a $\frac{3}{8}$ inch chisel, as shown in Fig. 76. The sides of the mortise may be worked with the piece in position, as in Fig. 74.

After you have the joint properly fitted, cut it in two and clamp it as shown in Fig. 77. Notice the little block at the end which keeps the clamp from hitting the end of the tenon. Use another

Fig. 75. Testing the Sides of the Mortise with a Narrow Chisel.

Fig. 76. Squaring the Inner End of the Mortise.

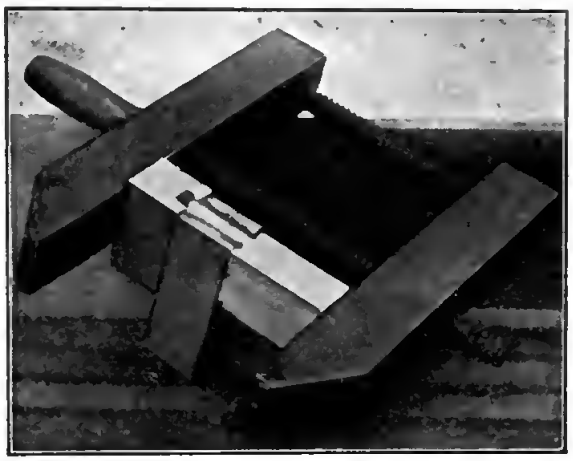


Fig. 77. First Clamp on the Slip Mortise and Tenon.

Fig. 79. Examine clamp, as shown in Fig. 78, with a block against the side of the tenon. Next remove the second clamp and place it as shown in the joint to see if it is tight at

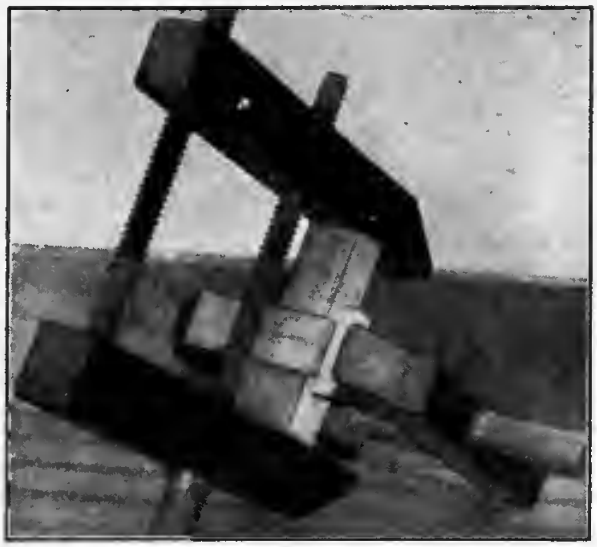


Fig. 78. Second Clamp on the Slip Mortise and Tenon.

the clamps in the same order, leaving only the last clamp on the joint while the glue is drying. Dress the piece to shape and size the same as the halved corner (Lesson 17). Sandpaper carefully and finish with two or three coats of shellac.

the sides and end, and square at the inside corner. If it proves to be all correct, remove the clamps and apply the glue. When the glue has dried until it is stringy or cobwebby, place the pieces together and clamp them as before. Apply

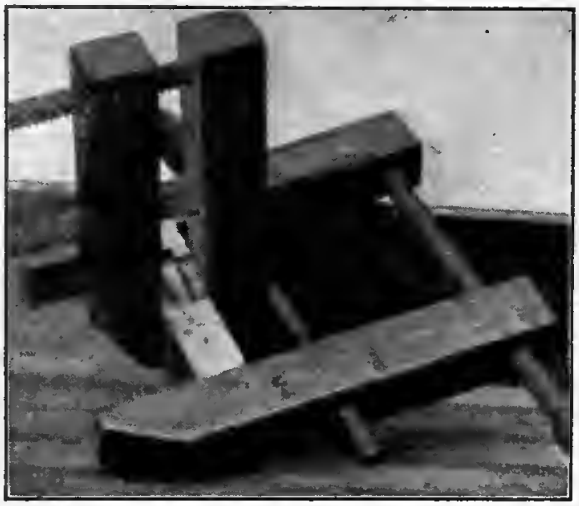


Fig. 79. Third Clamp on the Slip Mortise and Tenon.

LESSON XXII

Through Mortise and Tenon

The stock and finished sizes are the same as for the halved cross (Lesson 19).

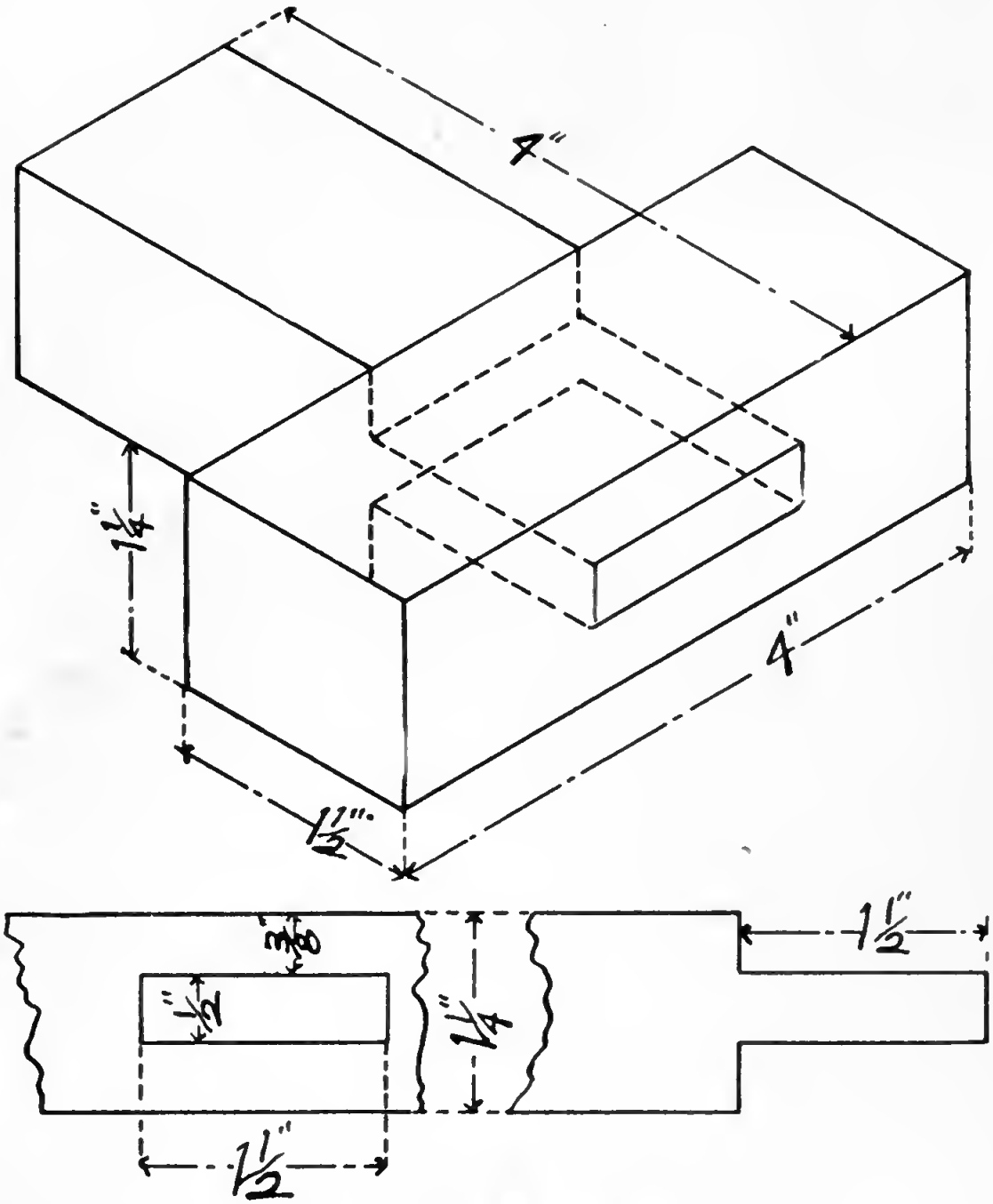


Fig. 80. Through Mortise and Tenon.

This joint is made in a manner similar to the slip mortise and tenon (Lesson 21). The chief difference is that, as the mortise is enclosed on all four sides, we cannot use a saw in working it. Instead of sawing out the mortise you should bore as many holes as can be made half way through from each side and then smooth the sides and ends with the chisel. (See Figs. 35, 36, 71, 73, 74, 75, and 76). This piece should fit together so exactly that it will not require gluing. You should do no work on either the mortise or tenon after the piece has been cut in two.

Dress the end of the tenon flush with the edge of the cross piece by using a plane, as in Lesson 17, Fig. 61 If the work is well done the face side of the joint will be exactly even when the pieces are placed together It must be considered a very serious defect if the face surface is not even, and you must try diligently to discover the place that is incorrect It may happen that you have the face-marks turned one each way, or that you were careless in drawing the lines, or that you did not draw the lines for both mortise and tenon at one setting of the gauge. Any of these mistakes must be considered quite serious at this time. You should now be able to draw lines correctly and work to them with considerable accuracy. Perhaps you can find the difficulty and yet make the joint correct After you have done your best,

finish the ends by sawing as explained in Lesson 20. Do not plane the sides or use any sandpaper on this joint.

LESSON XXIII

Frame Mortise and Tenon

The stock and finished sizes are the same as for the halved cross (Lesson 19).

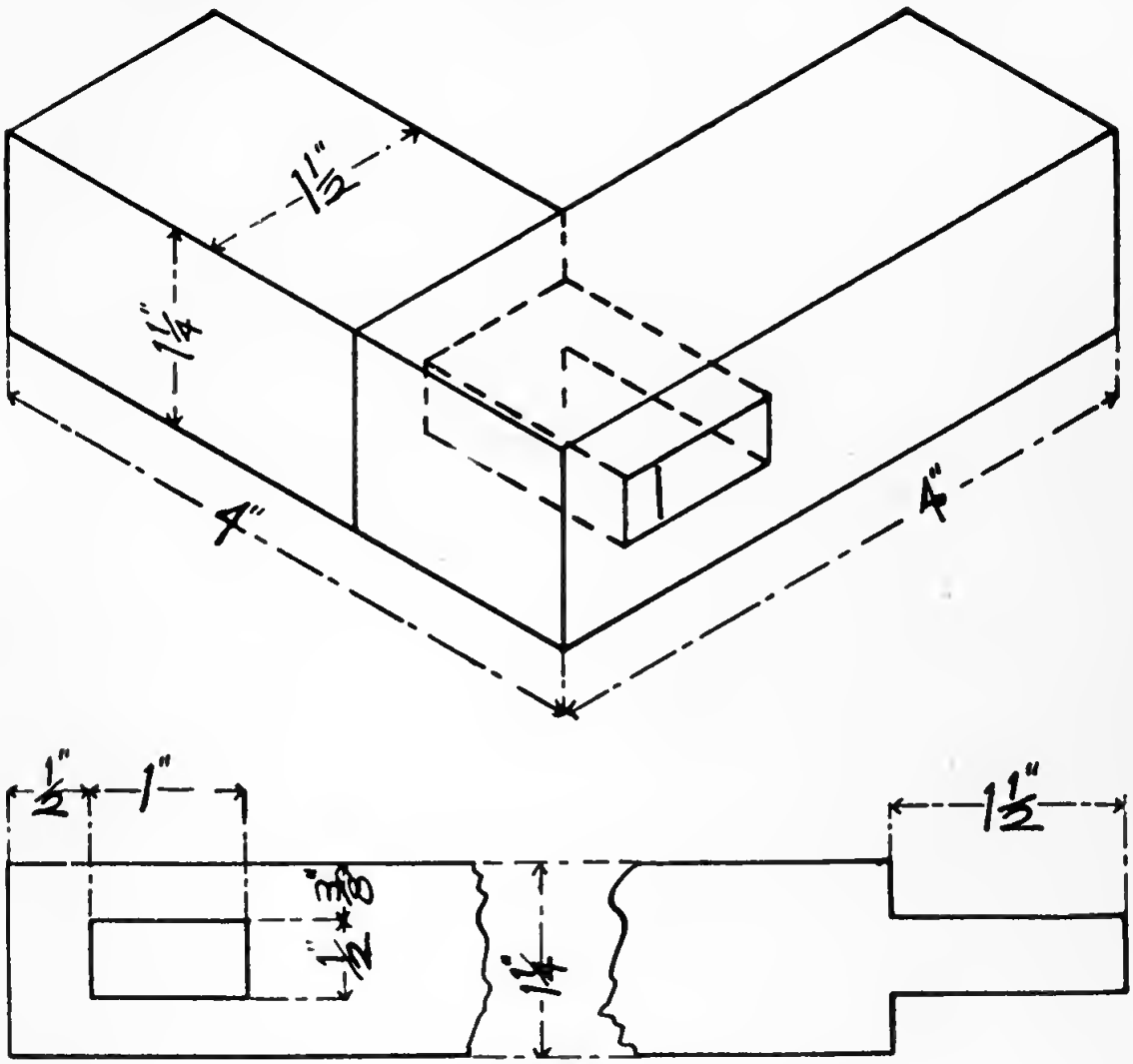


Fig. 81. Frame Mortise and Tenon.

Lay out and work the frame mortise and tenon the same as the through mortise and tenon, except that the mortise is smaller and near one end, and the tenon, after being worked to the full width of the piece, is gauged to 1 inch wide and worked to that size. Finish both mortise and tenon before cutting the piece in two. After the piece is together it is to be wedged by inserting a wedge in the end of the tenon near the outside edge.

Fig 82. Splitting Material for a Wedge.

To make the wedge, select a bit of straight-grained pine about 1 inch long, and split a piece from it about $\frac{1}{2}$ inch wide and $\frac{1}{8}$ of an inch thick, as shown in Fig. 82. Lay this piece on the bench-hook with one end against the vertical side and taper it as shown in Fig. 83. Turn the piece over and taper the other side in the same manner, giving the wedge a sharp wide end. Split the end of the tenon with a chisel, as shown in Fig. 84, and insert the wedge. Drive the wedge until the joint is tight, being careful not to drive the wedge in far

enough to split the end of the piece. After a little experimenting you will learn that a chisel is by far

Fig. 83. Making a Wedge.

Fig. 84. Splitting a Tenon.

the best tool to use for making wedges of this kind. Sometimes for larger joints the wedges are not sharpened to so thin an edge and, instead of splitting the tenon with the chisel, a saw kerf is made in it before it is put into the mortise. Wedges are not used as much now as formerly because glue and nails are so cheap and often far better to use than the wedges.

Finish this piece by planing the end of the tenon and also the end of the mortised piece which is at

the corner. Saw the outer ends, as directed in Lesson 20. Do not plane or sandpaper the ends or sides.

LESSON XXIV

Blind Mortise and Tenon

The stock and finished sizes for this exercise are the same as for the halved cross (Lesson 19).

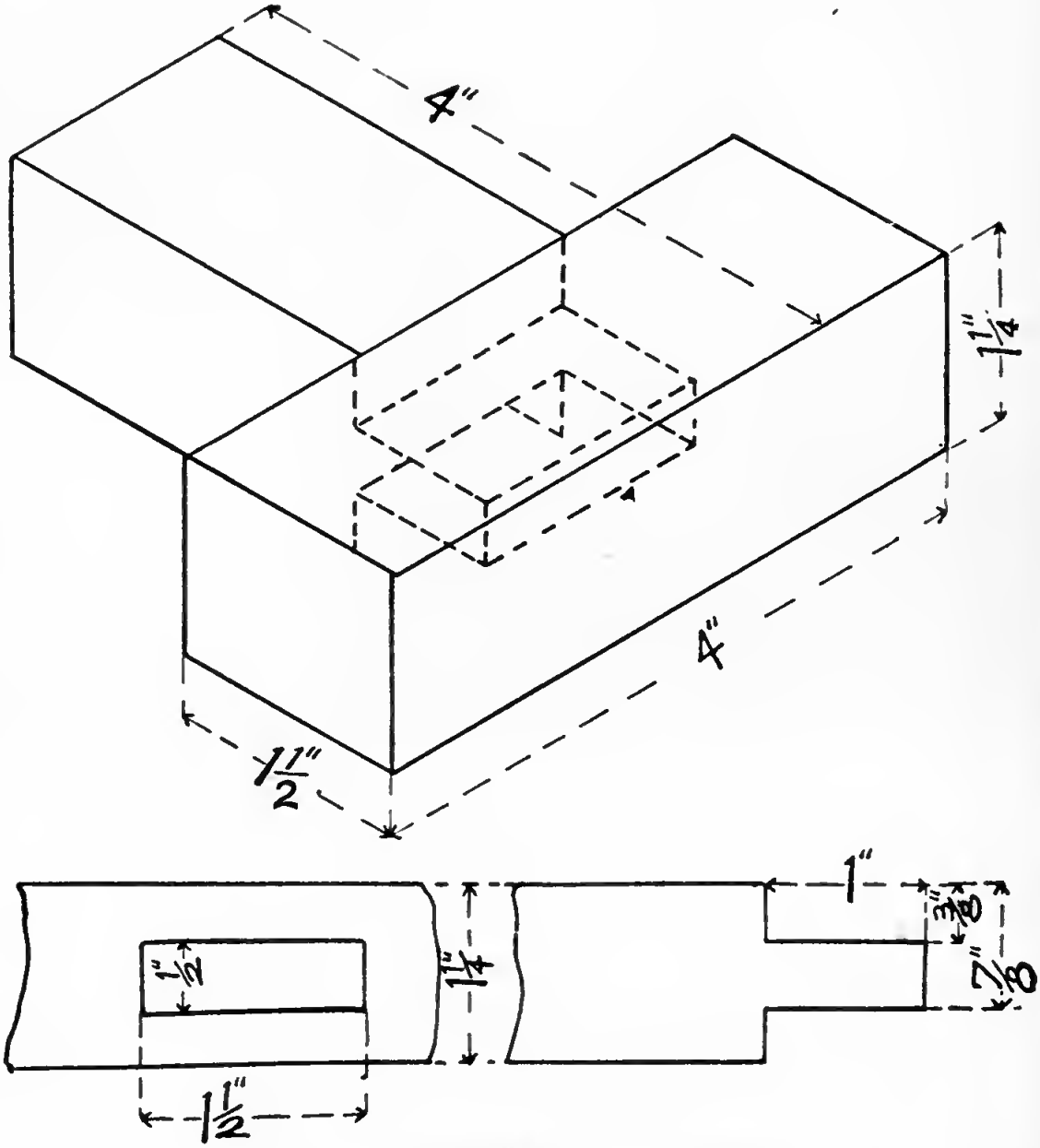


Fig. 85. Blind Mortise and Tenon.

The blind mortise and tenon is worked very much like the through mortise and tenon (Lesson 22). In the blind mortise and tenon the tenon is shorter and cut to length before putting together, and the mortise is lined out and worked entirely from the face edge. The most difficult part of the work is to beat or work the mortise so it will be at right angles, or square, with the surface. It must be also of the same size at both the top and bottomends. You must also guard against boring the holes entirely through. To make the holes of the proper depth you may count the turns of the bit or use a gauge on the bit. For most work it is best to depend on counting and thus avoid the bother of setting the gauge. The sides of the mortise may be tested by holding a chisel against the side, as shown in Fig. 86.

Fig. 86. Testing the Sides of the Blind Mortise.

When both the mortise and tenon are completed, draw lines around the center of the piece and saw it apart. Insert the tenon and, if it is all right, remove it and chamfer the lower end. Next make two small wedges and, after splitting the end, insert them as shown in Fig. 87. With the aid of the hammer drive the tenon to place. This is called blind wedging, and requires good judgment and experience to make the wedges of just the correct size, so that the joint will be tight when together, and yet not so tight that it will not go together. The bottom of the mortise should be quite smooth where the wedges strike it, or the wedges may turn to one side and not enter the tenon. Sometimes the bottom of the mortise is made wider than the top, or outer end, to allow room for the tenon to expand.

Fig. 87. Blind Wedging the Blind Mortise.

Finish the ends by sawing, as instructed in Lesson 20. Do not plane or sandpaper the sides. Leave them with the face marks on, just as they were before the piece was cut in two. This is to show that your lines were correct, and that the work was properly done.

LESSON XXV

Single Dovetail

The stock and finished sizes are the same as for the halved cross (Lesson 19).

Line out the end for the pin with the try-square, knife, and gauge. Work it to exact size, being careful to keep the edges at the end smooth and of correct size. With try-square and knife draw the

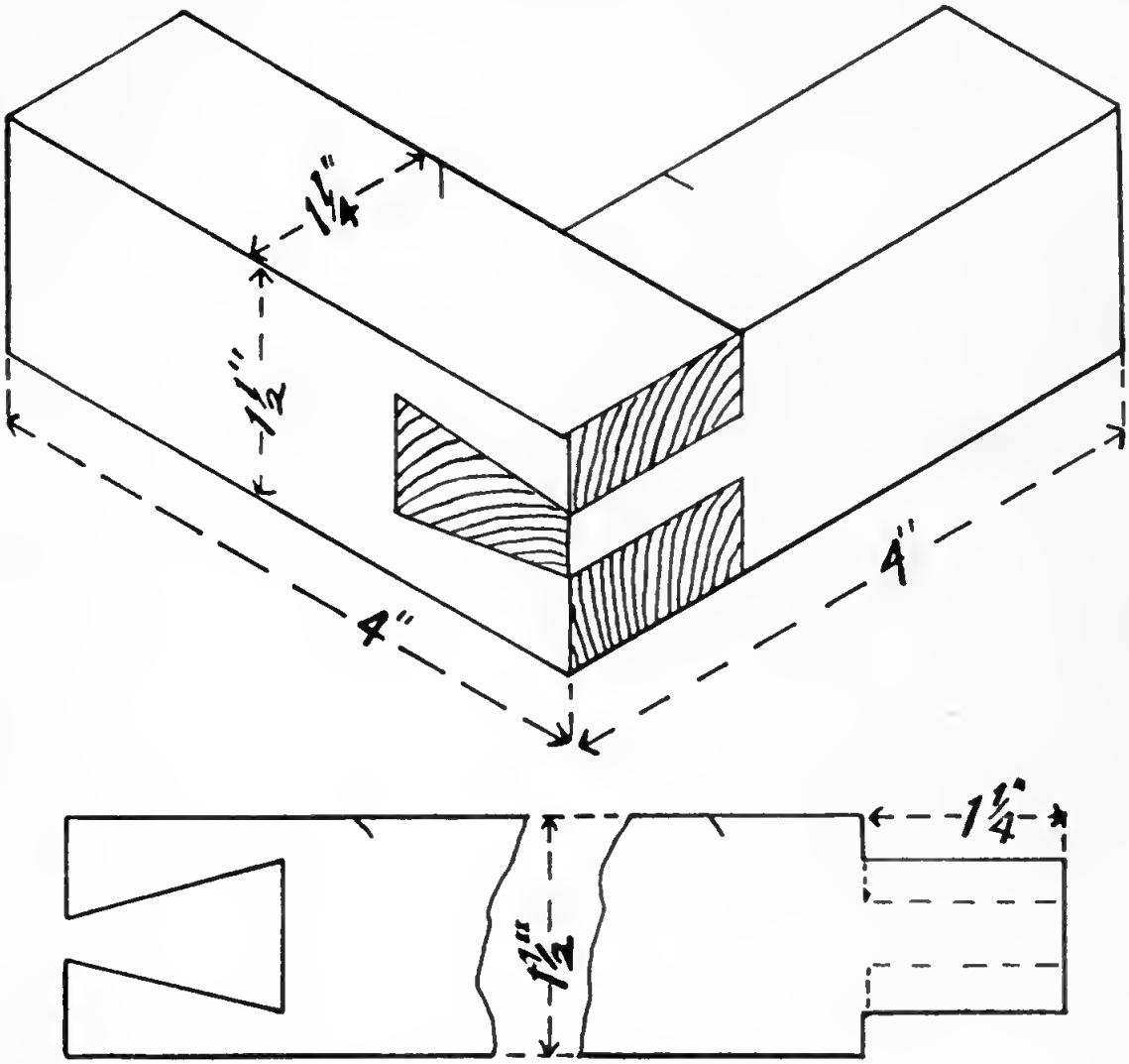


Fig. 88. Single Dovetail.

lines for the inside end of the mortise, allowing a little to be dressed off after the piece has been placed together. Draw lines around the center of the piece and saw it in two. Do not forget to have two sets of face-marks on the piece before it is cut in two, for the face-marks are of special importance in dovetailing. Be very careful to have the face-marks both on the same side even in these simple exercises, for unless you do this now you will be pretty certain to make serious mistakes when you try to make drawers, boxes, etc.

Set the pin on to the face side of the piece which is to receive it, with the inside edge even with the line drawn for the inside of the mortise. Draw a line at each side of the pin, using a sharp pencil or knife. Saw the sides of the mortise, as in Fig. 72, and finish the mortise with a chisel. A hole may be bored at the inside end of the mortise, or it may be cut out entirely with a chisel and mallet. In case no hole is bored first, cut down from each side a little away from the line and, after the piece of material has been removed, finish the end and sides to the lines. Sometimes the lines made on the face side are carried around to the other side by using the try-square and tee bevel; but this is not the ordinary way, for with a little practice the mortise may be worked correctly without drawing these lines and thus save much time. In working a mortise for a dovetail there is need of consider-

able care in keeping the chisel from jamming the edges beyond the lines.

Glue this dovetail together and finish it the same as the slip mortise and tenon (Lesson 21).

LESSON XXVI

Common Dovetail

Stock $12\frac{1}{2}$ inches long, $4\frac{1}{4}$ inches wide, and $\frac{7}{8}$ inch thick. Dress to 4 inches wide and $\frac{13}{16}$ inch thick.

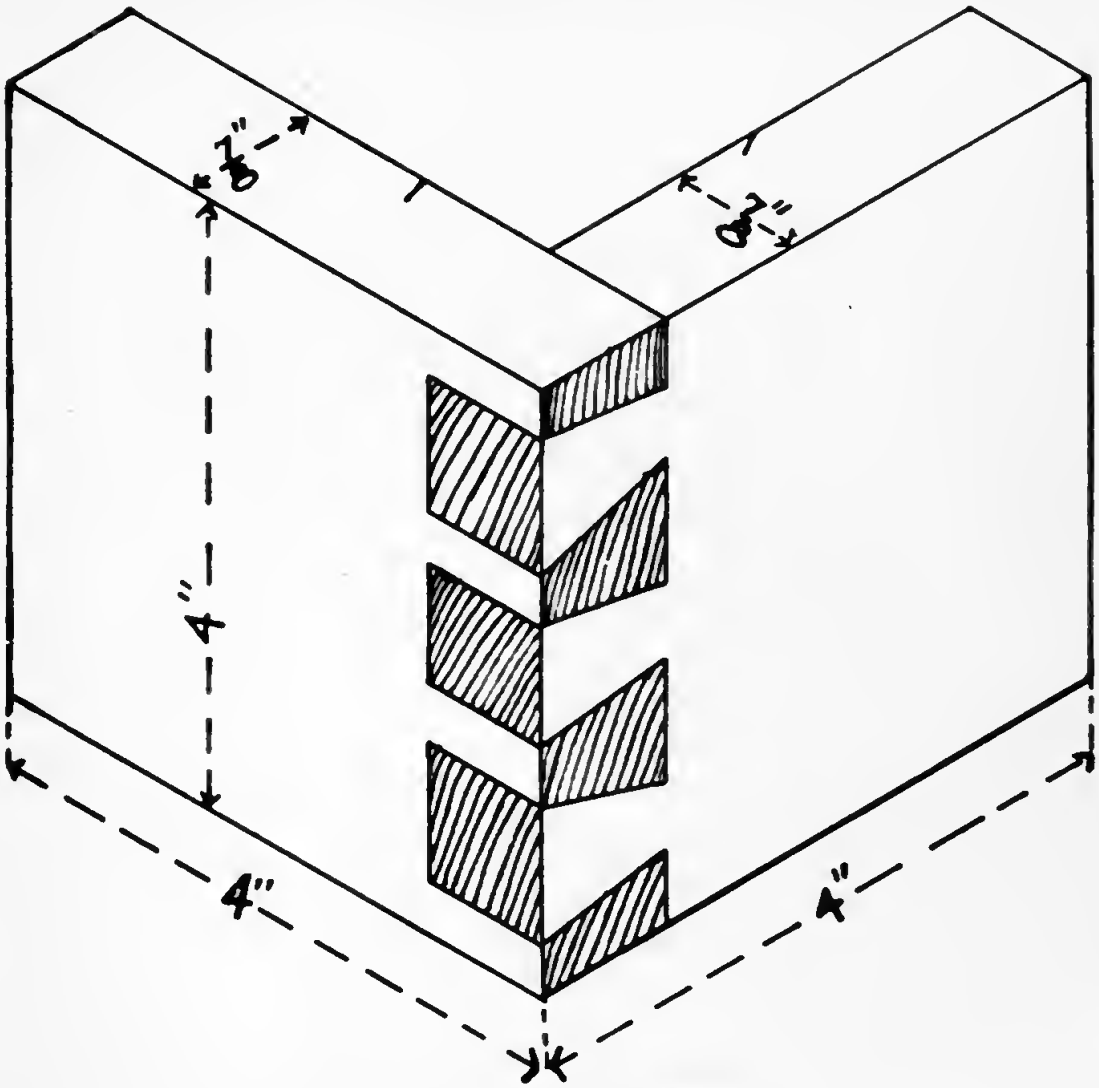


Fig. 89. Common Dovetail.

Square the ends carefully, testing them both from the face side and the face edge. In squaring the ends of this piece use the smooth plane as directed in squaring the end of the 4-inch-wide piece in Lesson 29. Draw lines around each end to mark the inner ends of both mortises and pins. These lines should be about $\frac{1}{32}$ of an inch farther from the ends than the thickness of the piece, so that there will be some material to plane off after the joint is glued together. In regular hand dovetailing the pins are not laid out by any measure, but by the eye unaided. They should have the general size and shape indicated by the drawing, and should be cut to nearly correct size with a fine rip-saw. They should then be finished with a chisel. The wide side of the pin is always on the face side of the piece, or the side which forms the inside of the corner. After the pins are carefully smoothed set them on end on the face side of the piece which is to receive them and mark around them with a sharp pencil or knife, as shown in Fig. 90. Do not

Fig. 90. Scribing Around the Pins for the Mortises.

use the bit in working these mortises, but work them entirely with the chisels.

Sometimes dovetails are laid out of exact shape and size, the pins being marked on both sides and ends, and the mortises lined around with square and tee bevel after one side has been scribed from the pins. Sometimes the mortises are made first and the pins scribed from them, as in Fig. 92. In common drawer dovetailing the ends of the pins and the outside of the mortises are battered down with a hammer after the joint is glued. This battering holds the joint together while drying and helps to fill up any defects in the joint. In our practice work it is better to make the joint so perfect that it will not require either gluing or battering. If your work is well done, place the pieces together without gluing and plane off the waste material at the corner and finish the outer ends as you did the halved dovetail in Lesson 20. If your piece is not good enough to finish in this manner, cut the mortises off, refinish the pins, and try again. Should you have to try a third time, cut off the pins, refinish the mortises, and scribe a new set of pins from them. This form of dovetail is usually used at the back end of drawers in fine hand-made furniture.

LESSON XXVII

Half Blind Dovetail

Stock and finished sizes the same as in Lesson 26.

Lay out and work the pins the same as in Lesson 26, Fig. 90, except that the narrow edges of the pins do not extend through to the back or outer surface, about $\frac{1}{4}$ inch of material being left to conceal the

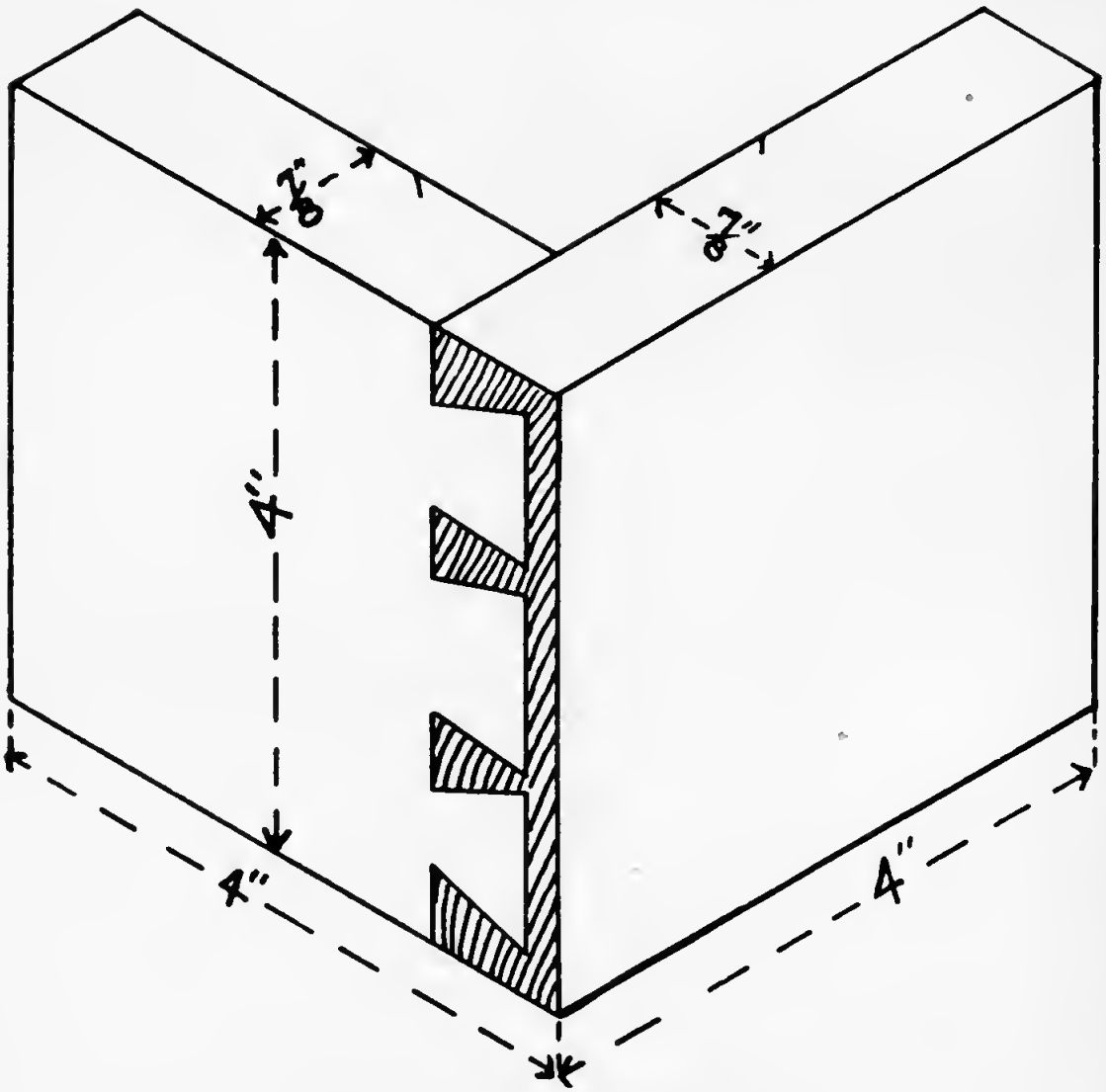


Fig. 91. Half Blind Dovetail.

joint, as shown in Figs. 91 and 92. The leaving of the $\frac{1}{4}$ inch to conceal the joint requires the mortises to be made $\frac{1}{4}$ inch less in length than the thickness of the piece which is to receive them. This length must be exactly correct before putting together, as there is no opportunity to dress them off afterwards, as is the case with the common or open dovetail. The pins may be dressed off after the joint has been put together, and are therefore left long. This extra length may be used to batter down after the joint is glued, the same as described in Lesson 26.

Fig. 92. Scribing in the Mortises for the Pins.

Make this joint so perfect that it will not require gluing and finish it with two coats of shellac. This form of dovetail was used for many years for the fronts of drawers, but machine dovetailing has now taken its place almost entirely except for expensive hand-made work.

PART II

Supplementary Exercises

The following exercises are not usually given to the whole class. Some pupils who are especially quick will require some work in addition to that given to the remainder of the class. Others will have projects which contain elements requiring a study of these special problems These exercises should be executed with quite as much care and accuracy as those in the body of the book.

Fig. 93. Sawing with a Hand Saw.

LESSON XXVIII

Getting Out Stock

Where there are no power saws it will be necessary to get out stock by hand. This will require two sawhorses, a handsaw and a ripsaw. The handsaw should be about 26 inches long and have about 8 points to the inch. The ripsaw should be about 28 inches long and have about 6 points to the inch.

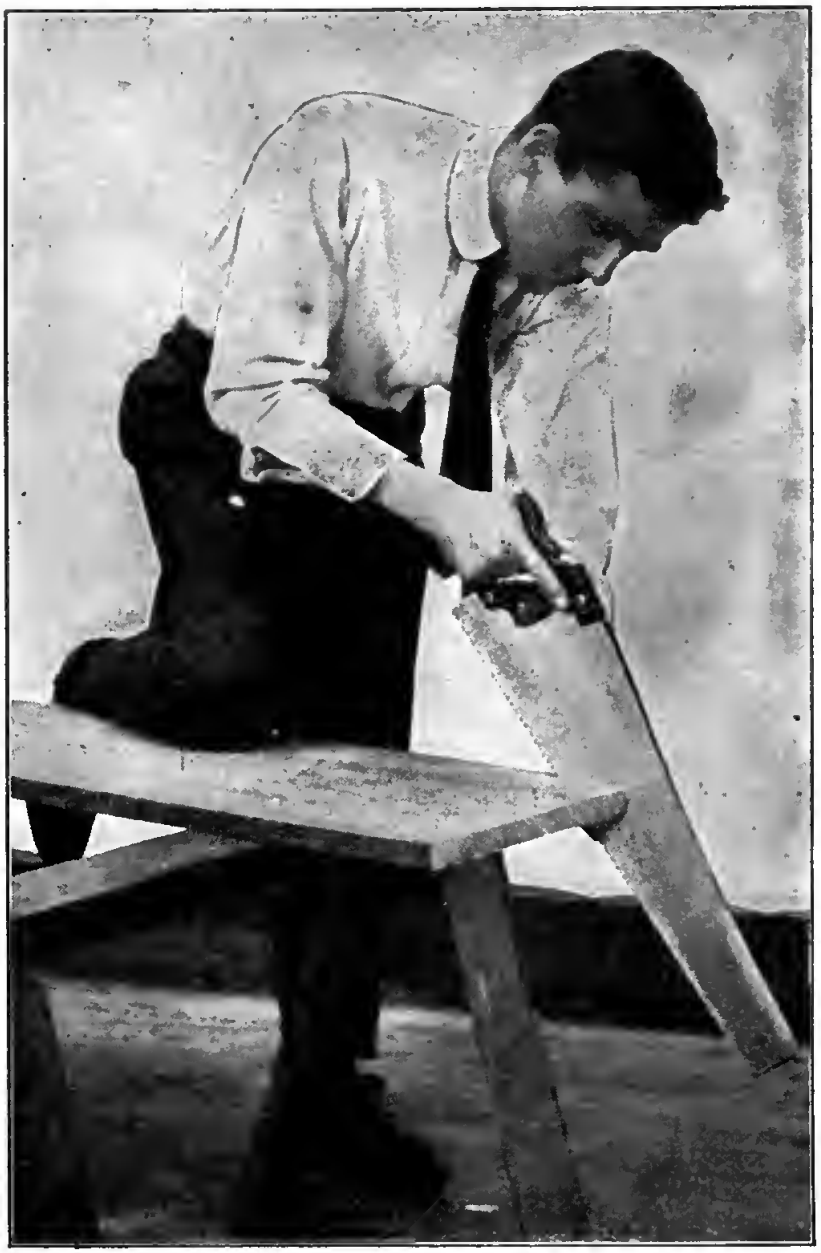


Fig. 94. Sawing with a Ripsaw.

The general principles involved in getting

out stock with these large tools are much the same as in working with smaller tools on the bench. Always take such a position as will allow of seeing a right angle at the side of the saw. Avoid a position which will cause you to look directly down upon or over the saw. The general positions are shown in Figs. 93, 94, and 95.

Fig. 95. Sawing with a Try-Square at the Side of the Saw.

For making lines on rough lumber use a carpenter's square (Fig. 197) and one or two straight edges. One straight edge should be about 4 feet long, 3 inches wide, and $\frac{1}{2}$ inch thick. Another straight edge 8 feet long, 4 inches wide, and $\frac{7}{8}$ of an inch thick will be required

where many long pieces are worked. For drawing the lines use a carpenter's pencil.

Calculate carefully all the dimensions, including all the allowances for working, and then draw the

Fig. 96. A Plane Used as a Straight Edge.

lines carefully and saw to the lines. Each piece of rough lumber should be examined carefully before laying out, and the lines made with proper regard for grain, knots, sap, worm holes, etc. Often a small knot, when it can not be cut out, may be placed well away from the sides or ends where it will do little or no harm. Twisting and bending while working are often the result of poor judgment in cutting out the stock. A constant watch for these points will save much time and material.

Probably the most common error in getting out stock is to work all of a board or plank into one sort of stock, when by using a part for one exercise and leaving the remainder for a different exercise would give better results and save much extra labor and material. In dressing wide stock the plane may be used as a straight edge, as shown in Fig. 96.

LESSON XXIX

Bench-Hook

Stock—One piece $14\frac{1}{2}$ inches long, $4\frac{1}{4}$ inches wide, and $\frac{7}{8}$ inch thick; two pieces each $12\frac{1}{2}$ inches long, $2\frac{1}{4}$ inches wide, and $\frac{7}{8}$ inch thick.

Dress the wide piece to 4 inches and as thick as it will work. Be quite as careful in planing these pieces out of wind and straight as you were in working the first piece (Lessons 1 to 4). Draw knife lines around one end and saw it off the same as for smoothing the end with a chisel. With the smooth plane held as shown in Fig. 98, plane carefully to the line at the corner next you, but do not plane to the opposite corner. When you have planed down to the line at the nearest corner, either reverse the piece or step to the opposite side and plane the end square. Test the end with the head of the try-square against both the face side and the face edge. Always place the piece as

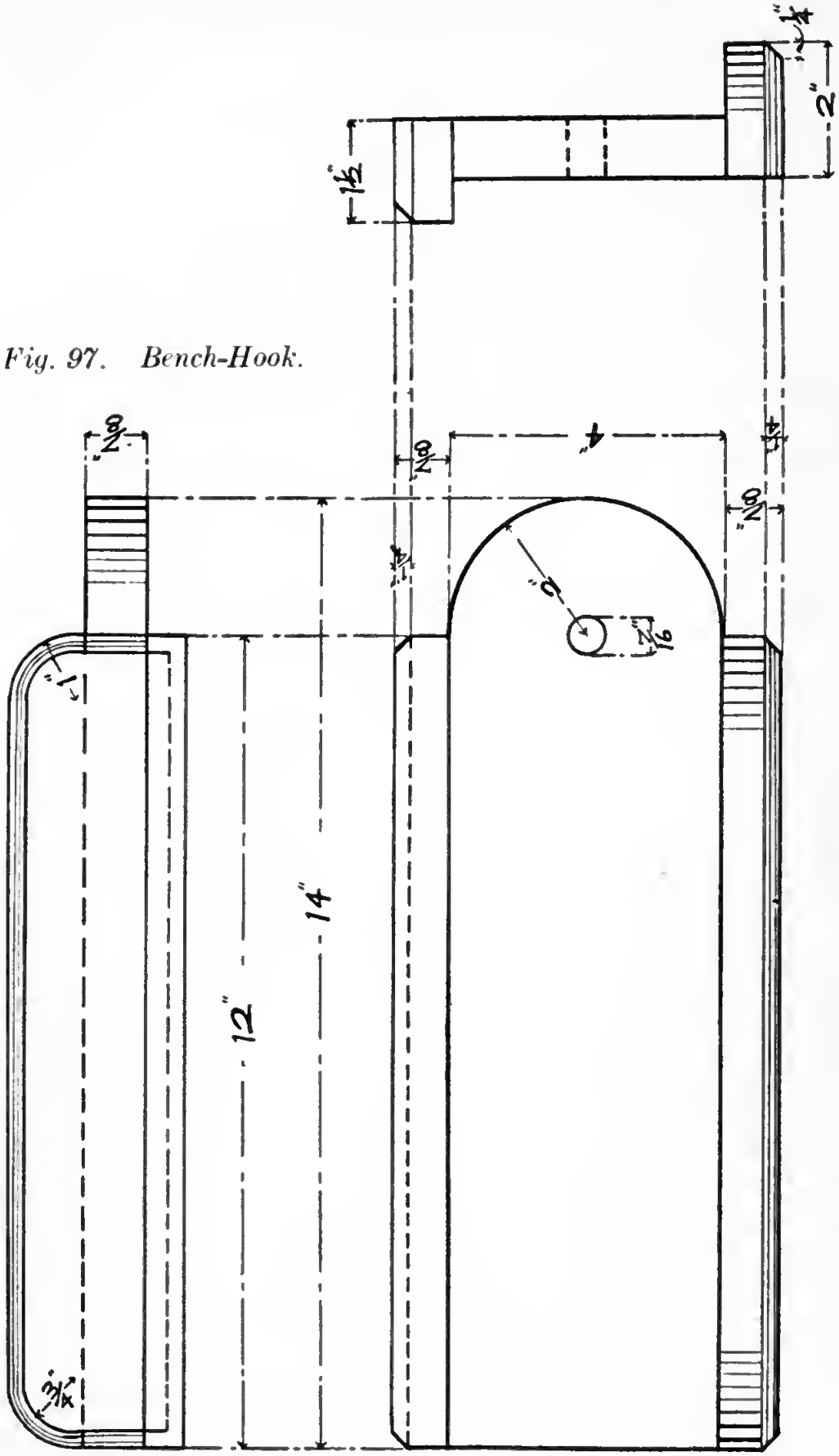


Fig. 97. Bench-Hook.

Fig. 98. Planing an End Square in the Vise.

low down in the vise as you can to avoid chattering. This will hold the piece more rigid, and consequently there will be less liability to roughen the edges or split the corners.

If by mistake you plane beyond the lines, do not try to plane by guess, but draw other lines on both sides and edges. You will notice that if you stop at the lines the edges will be sharp and smooth, but if you plane the least bit beyond the lines, the edge will be rough. Therefore, always have lines on all sides and edges, and stop exactly at them. If by accident you split one of the corners you may leave this end to be rounded and try to square the other end; but remember that if you do

Fig. 99. Setting Compasses on a Rule.

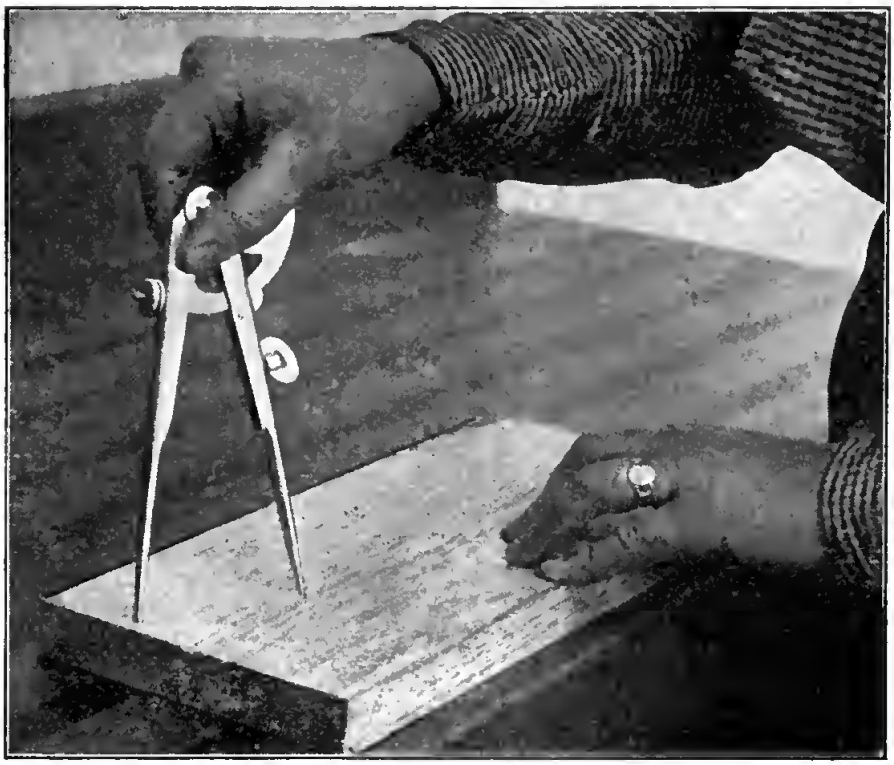


Fig. 100. Striking a Circle with Compasses.

not plane entirely across the end the corner will not be split.

After squaring one end set the compasses to 2 inches as shown in Fig. 99, and place one point 12 inches from the square end and at the center of the width, and strike a semicircle, making the extreme length of the piece 14 inches. Hold the compasses in striking the circle as shown in Fig. 100.

With the backsaw saw the corners off near to the circle. Finish the circular end with a

Fig. 101. Chiseling a Round End.

chisel (as shown in Fig. 101), using a shearing cut as in chiseling the ends of the first piece (Lesson 13). Test the circle as shown in Fig. 102. Bore a hole at the center of the semicircle (as shown in the drawing, Fig. 97), with a $\frac{7}{16}$-inch bit. Remember to bore from both sides.

Fig. 102. Testing a Round End.

Dress one of the $2\frac{1}{4}$ inch-wide pieces to 2 inches wide and $\frac{13}{16}$ inch thick and saw the ends, leaving just enough to finish with the plane, the same as the wide piece which you have just completed. This piece may be only $1\frac{1}{2}$ inches wide, yet it is better to have it 2 inches wide. Should you split the corners, or for any cause need to reduce it in width, you may do so rather than use another piece.

With the gauge set at $\frac{1}{4}$ inch, mark on the edge and ends for the chamfer as shown in Fig. 97.

Fig. 103. Planing a Chamfer.

With the smooth plane dress the corner off to the gauge lines, holding the plane as shown in Fig. 103. Place the piece on end in the vise, having the top end of the piece as near to the top of the bench as you can to work the chamfer. The lower down the piece is the less liable the plane is to chatter or split the corner. With the plane held as shown in Fig. 104, plane to the lines at the ends. The plane is held at an angle of about 45 degrees, but moved parallel with the

Fig. 104. Planing a Chamfer at the End.

edge, and not parallel with the length of the plane. If the plane is in proper condition, not too much set, and held properly, the corners will not split.

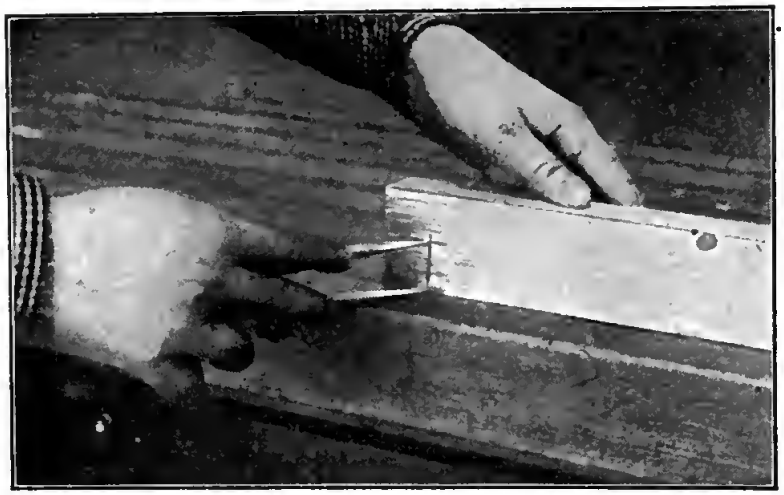


Fig. 105A. First Step in Locating the Point at Which to Set the Compasses.

Work the second piece to 2 inches wide, $\frac{13}{16}$ inch thick, and 12 inches long. You should be able to finish the ends of this piece very nicely with the plane. After the ends are properly squared set the compasses to 1 inch as shown in Fig. 99. Find the point at which to set them for marking the round

Fig. 105B. Second Step in Locating the Point at Which to Set the Compasses.

corner (as shown in Figs. 105A and 105B), and scribe quarter-circles at the two corners opposite the face edge. Saw the corners off and then chisel the surface the same as the round end of the wide piece. Test them as in Fig. 102.

Fig. 106. Chiseling a Chamfer on a Circle.

With the gauge set at $\frac{1}{4}$ inch, line the corners of the edge and ends for chamfering as shown in Fig. 97, plane the chamfer at the edge and on the straight parts of the ends as shown in Figs. 103 and 104, and finish the chamfer at the rounded corner with the chisel as shown in Fig. 106. The circle may be chamfered with the plane, but it is rather difficult to do so. In rounding ends and planing chamfers on ends where the circle is of large radius, it is better to use the plane rather than the chisel.

Nail the pieces together as directed in Lesson 7. This bench-hook should be nice enough to receive one coat of shellac. For use in larger work one should have a bench-hook of larger size.

LESSON XXX

Rabbeted Joint

Stock $8\frac{1}{2}$ inches long, $4\frac{1}{4}$ inches wide, and $\frac{7}{8}$ inch thick. Work the piece to 4 inches wide and as thick

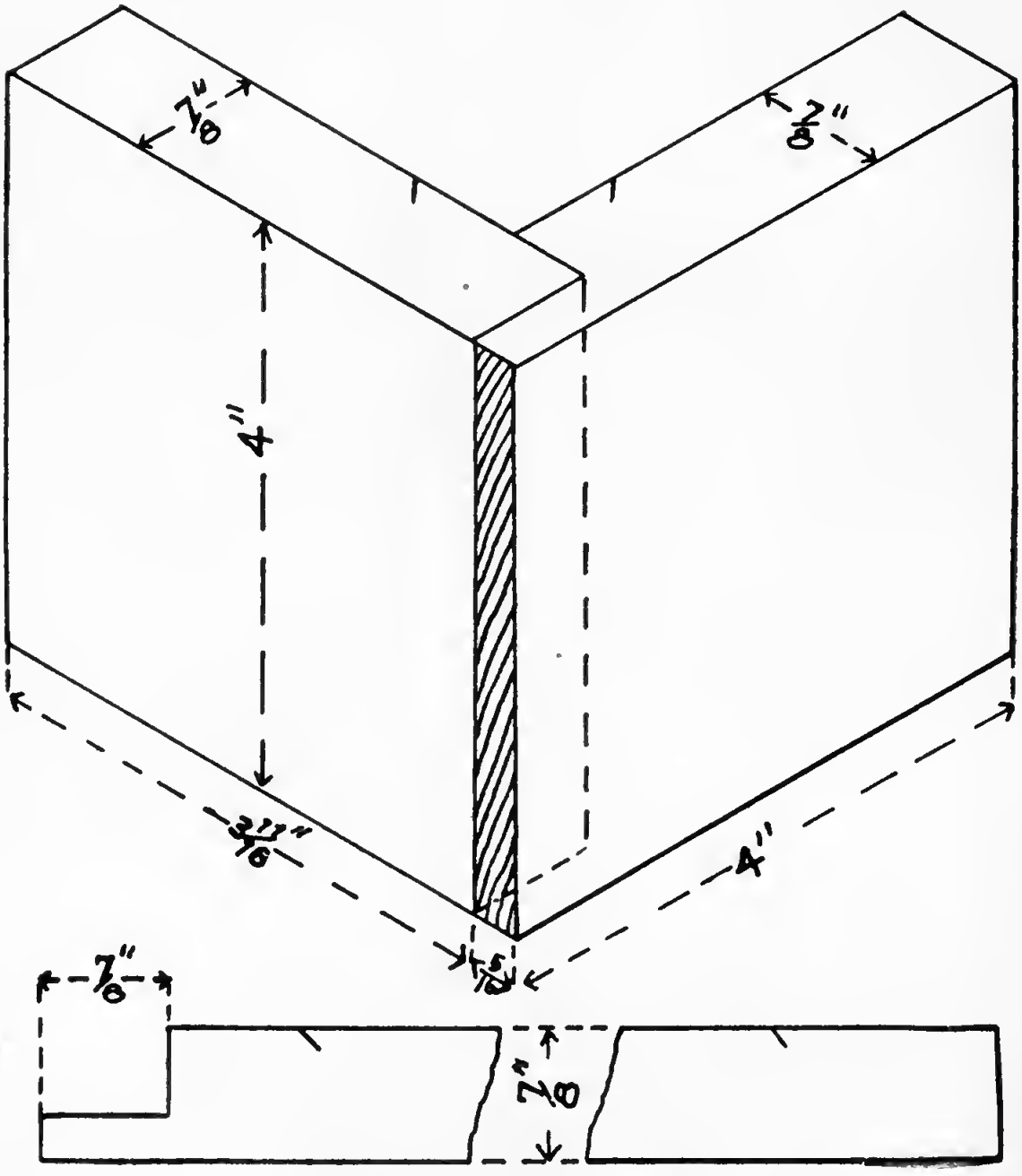


Fig. 107. Rabbeted Corner.

and long as it will work. Be careful to have it out of wind and the ends correct. In planing the ends observe the directions given in Lesson 29.

Draw the lines for cutting the rabbet, following the same method as in lining for the gain at the end of the halved corner (Lesson 16). The working of the rabbet also follows the same methods as working the halved corner.

Fig. 108. Nailing a Rabbeted Corner.

Cut the piece in two and finish the ends, making the model 4 inches long on the outside when completed. Sandpaper the pieces, except at the joints, ready for shellacing before putting together. Start the nails as directed in Lesson 7. Place the rabbeted piece in the vise and nail the other piece in place, as shown in Fig. 108. For nailing use five $1\frac{1}{2}$-inch wire brads. Set the brads about $\frac{1}{32}$ of an inch below the surface, using a nailset or the head of a brad (Figs. 27 and 28). Smooth the joint if required, and fill the nail holes with putty colored to match the wood. Use the putty quite hard and force it well down upon the heads of the brads. After the putty has become

hard, smooth it off with sandpaper and finish the joint with two coats of shellac.

This joint is used to a very great extent for the front end of cheap drawer sides and for small boxes. When used on a box the corner is often rounded back to the joint, and it will then finish quite neatly in shellac or varnish.

LESSON XXXI

Gained and Rabbeted Corner

The stock and finished sizes are the same for this lesson as for Lesson 30.

The rabbeted end is worked similar to the one in Lesson 30. The gain is worked similar to the one in Lesson 18. The work on this joint must be well executed in order to have it hold properly. After the pieces are worked to size and carefully sandpapered as directed in Lesson 30, they may be glued together or nailed.

If the joint is to be glued, it will be much stronger if the pieces have their end grain properly sized before putting together. To size the pieces apply glue to the end grain as long as it will soak in, and then apply glue to the other parts and put the pieces together. If we allow the glue to dry hard, and then smooth it off down to the wood before applying the glue for putting together, it will make the joint hold even better.

This joint is used on box and drawer corners and similar places. This joint, and also the one

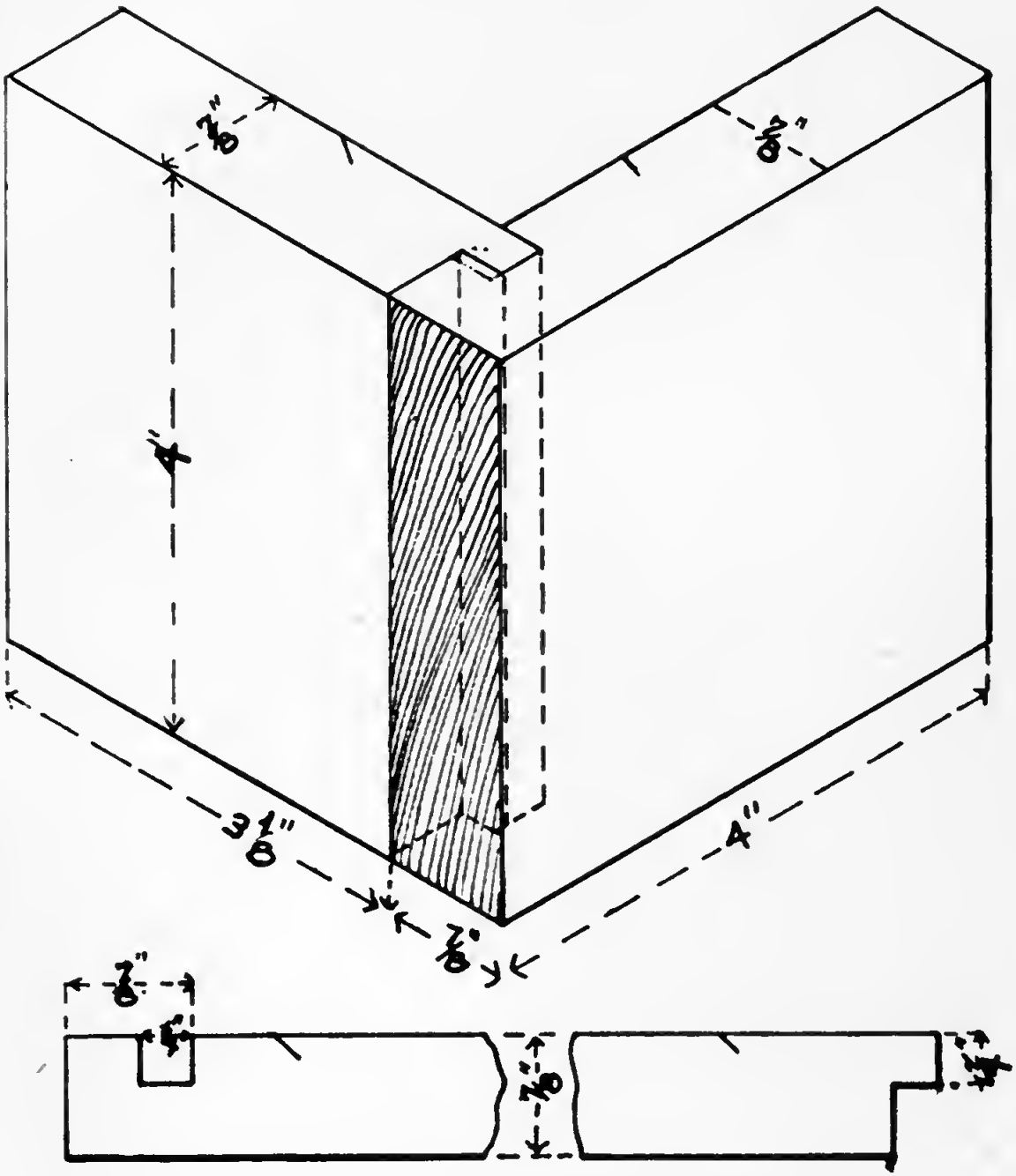


Fig. 109. Gained and Rabbeted Corner.

shown in Lesson 30, may be made entirely on a circular-sawing machine. For this reason it is much

used in small shops where they do not have the more expensive machinery for dovetailing.

LESSON XXXII

Bridle Joint

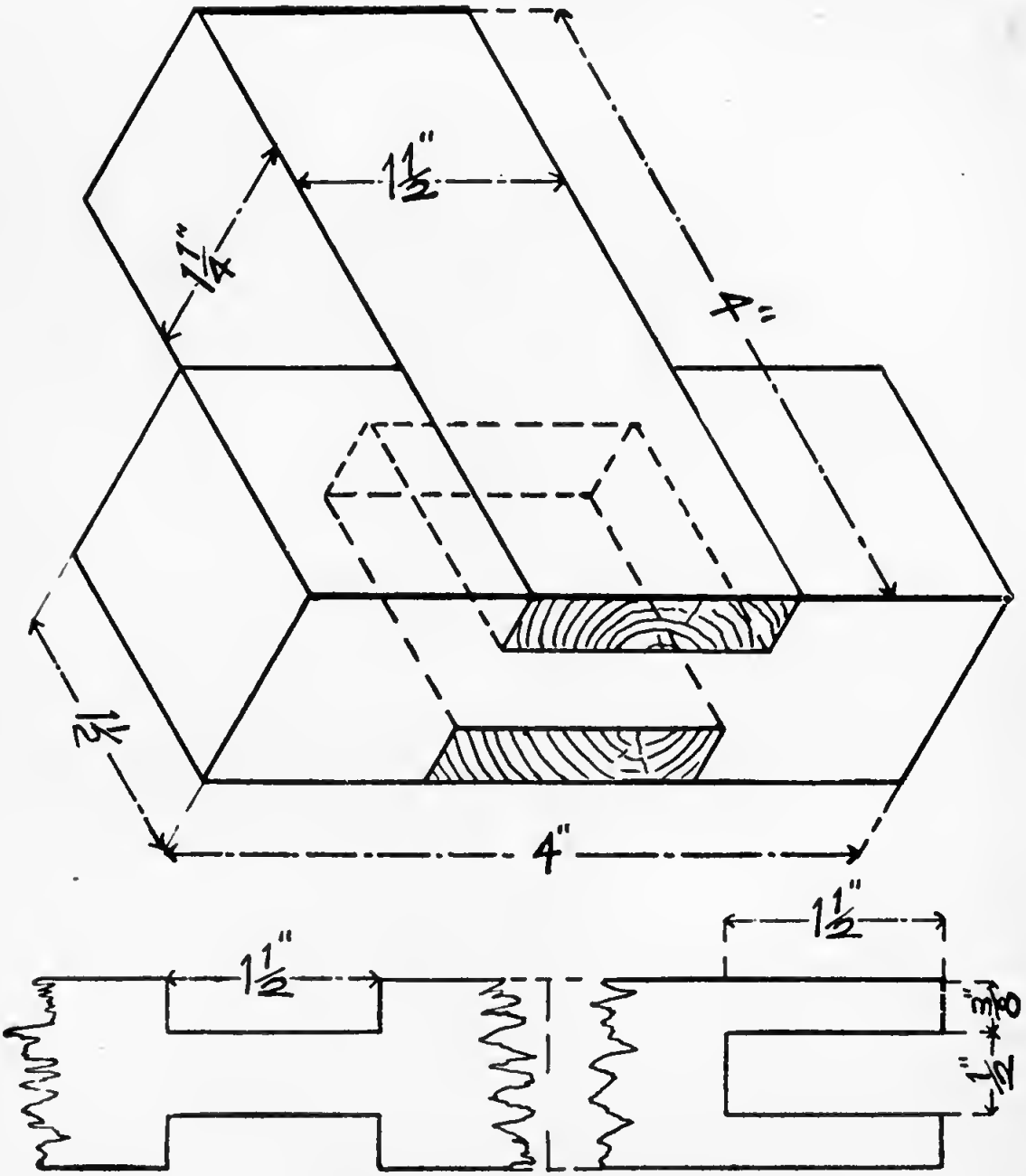


Fig. 110. Bridle Joint.

The stock for this joint is the same, and worked the same, as the through mortise and tenon, except that the opposite parts are cut away. Gauge the same as the through mortise and tenon (Lesson 22). Determine the width of the gains at each side either by superposition as in Lesson 18, or by measurement as in Lesson 22. This exercise is an excellent test, for if the piece is not worked to exact size and all four corners square, the inaccuracy will be likely to cause an open joint. Slip the piece together and finish the same as the through mortise and tenon (Lesson 22). Do not plane the sides or use any sandpaper to smooth the joint.

This joint is very seldom used outside of school.

LESSON XXXIII

Haunched Mortise and Tenon

The stock for this exercise and the finished sizes are the same as used in Lesson 19.

This exercise illustrates a variety of modifications of the common mortise and tenon, and, when properly understood, should enable one to make any of the large variety of modifications. All of the irregular-shaped tenons depend upon care in selecting the proper order for working the various angles and shoulders, and in always keeping a face, or definite surface, to line from, and working carefully to the lines at each step. Where a part of

the tenon is to be cut away as in Lesson 23, frame mortise and tenon, and in this exercise you must be especially careful to keep the surface of the tenon correct from edge to edge, so that when a part of the tenon is cut away you will not lose your correct edges.

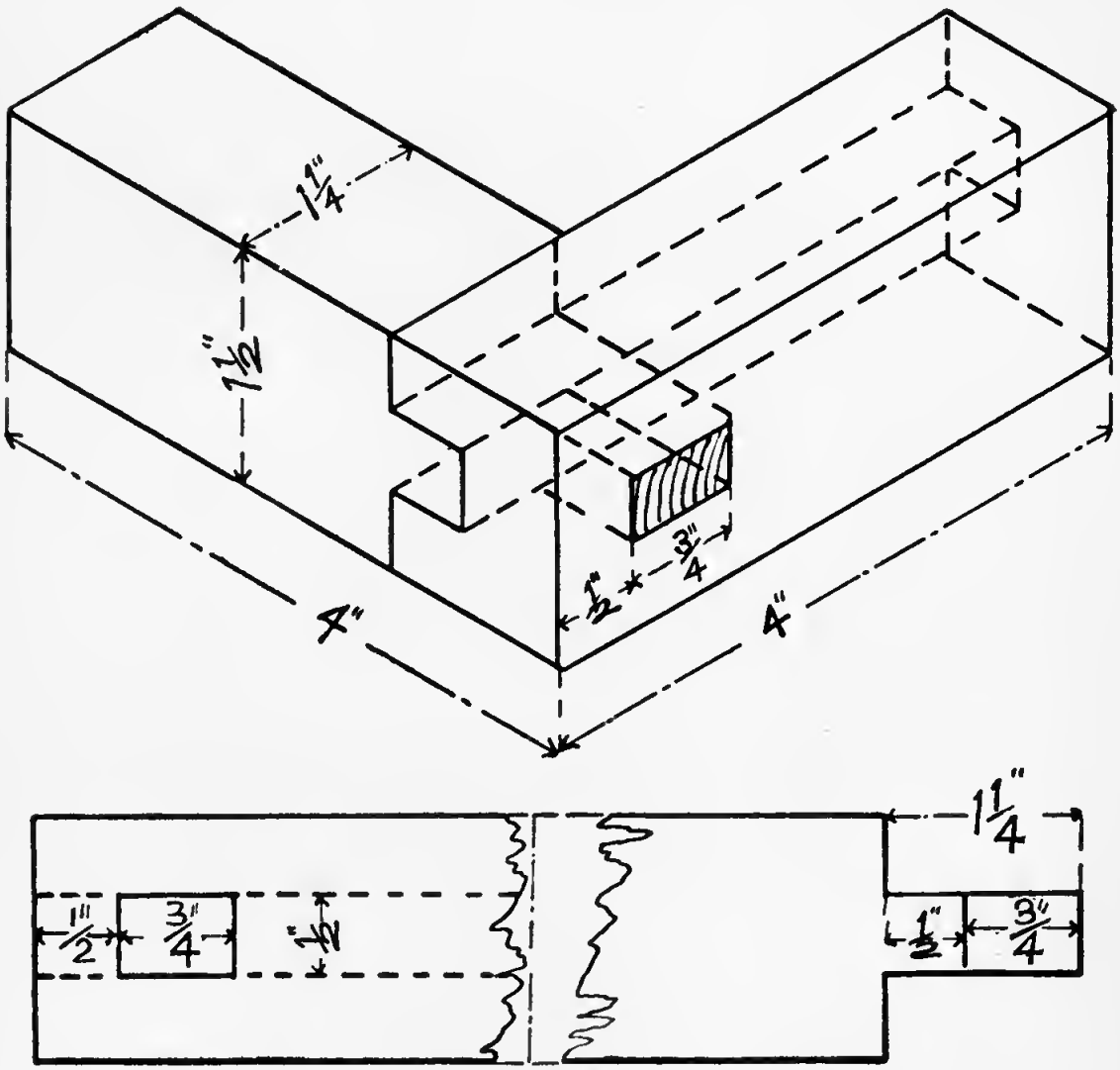


Fig. 111. Haunched Mortise and Tenon.

With these facts in mind you should be able to make this exercise from the drawing by reviewing Lesson 23. The difference between these exercises

is in the leaving of a shoulder on the tenon to fit into the groove which extends the entire length of the piece that contains the mortise. This arrangement is common to joints used about paneling.

The groove is usually worked with a plow; but in this case you will work it by drawing gauge lines at each edge of the groove and at the ends, and remove the waste material with a chisel.

LESSON XXXIV

Dowel Joint

The stock for this exercise is the same size, and worked to the same size, as that used in Lesson 19.

It is often better to connect two pieces with dowels instead of with mortises and tenons. Doweling is used much more at present than formerly, and for some lines of work is to be preferred.

Work the stock to size and carefully square the end which is to receive the dowels. Draw a line with the gauge at the end which is to receive the dowels. This line should be at the center of the piece and parallel with the sides. With the knife and try-square draw a line on the face of the other piece which will exactly coincide with the line drawn on the end of the first piece. It is sometimes better to lay the pieces in position as they will be when the joint is complete, and with the point of the

knife blade make a mark on both pieces at the same time, as shown in Fig. 113. Next set the gauge to the mark on the end, and extend it across the end. With the try-square and knife extend the other mark

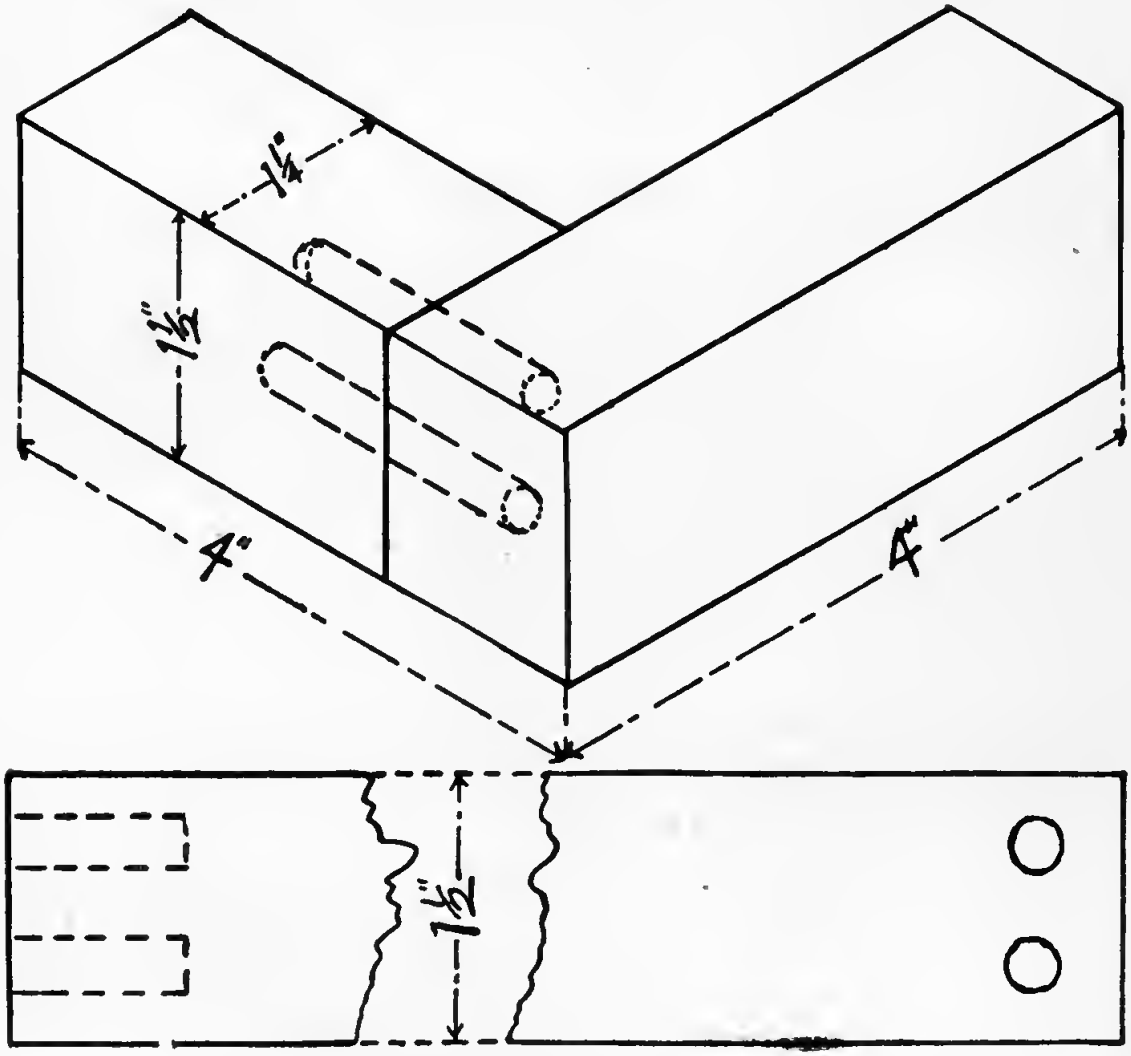


Fig. 112. Dowel Joint.

across the face of the other piece. With the gauge set at ½ inch and the head against the face edge, draw short lines crossing the other two lines. Set the gauge to 1½ inches and draw two other short lines.

With the ⅜-inch bit bore a hole at each of the four places marked by the crossing of the lines. Be

very careful to have the holes center exactly where the lines cross. Remember not to bore entirely through the piece which has the holes in its face side. Bore about $1\frac{1}{2}$ inches into the end. Cut two dowels 2 inches long from $\frac{3}{8}$-inch dowel rod. After placing glue on the dowels and in the holes, force the pins to the bottom of the short holes either by using a hammer or a clamp. Then place the other piece in position and force it to place with a clamp. Dowels and other joints which cannot be forced together by hammering may sometimes be forced together by using clamps. It is usual to point the pins a little. If cold glue is used allow it to become quite dry before putting the pieces together.

Fig. 113. Locating Holes for Doweling.

Glue on the end and surface of the pieces will help to make a good joint for finishing, although it is not likely that it will add much to the strength unless the end grain is first sized with glue. (For directions for sizing see Lesson 31.) Glued dowels are used only when one or both pieces are joined at their ends. Dowels should not be used in regular glue joints.

LESSON XXXV

Special Dovetail Joint

Stock—One piece 8 inches long, $4\frac{1}{4}$ inches wide, and $\frac{7}{8}$ inch thick; one piece 8 inches long, $4\frac{1}{4}$ inches wide, and $\frac{1}{2}$ inch thick.

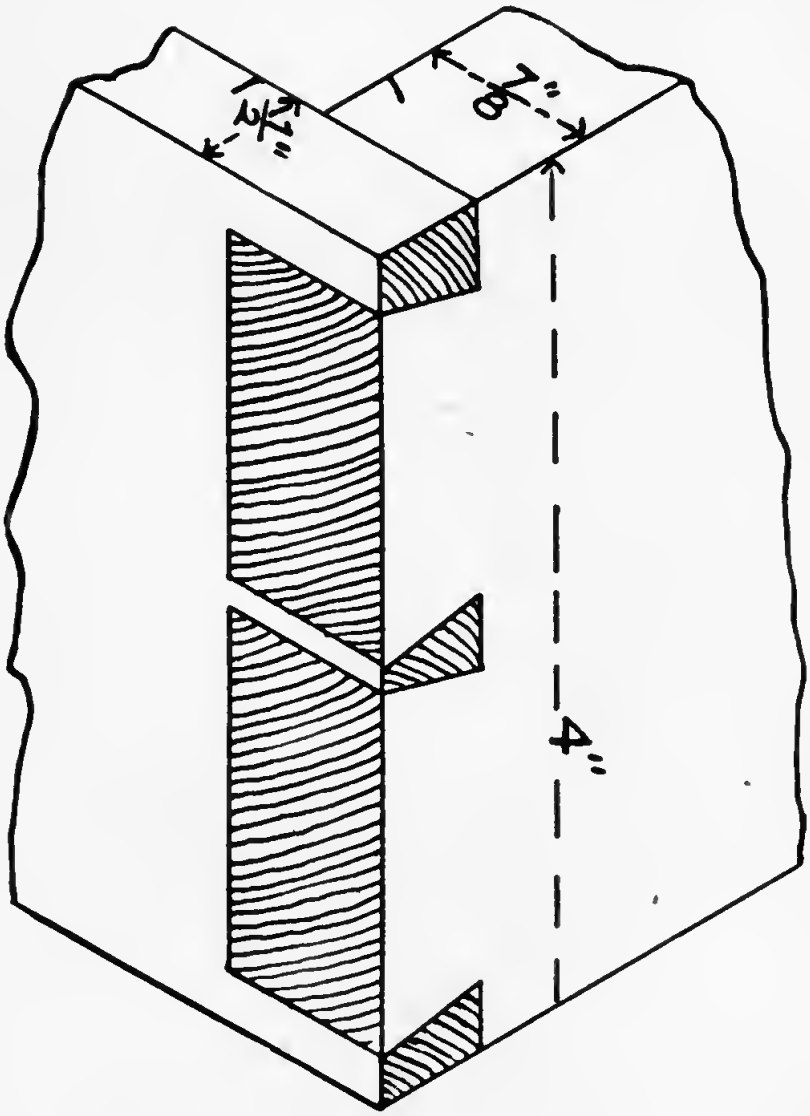


Fig. 114. Special Dovetail Joint.

These pieces are dressed to 4 inches wide and as thick as they will work. Be sure that they are out of wind.

The forms of dovetailing shown in Lessons 26 and 27 require more time to make than is sometimes desirable, therefore a form having fewer pins is used. You must ever keep in mind that the form, number of pins, their size, shape, etc., are subject to

all the variations which may arise from the use of various kinds or grades of wood and the places in which the joints are to be used. The particular form shown in the lesson is only a type to indicate the possible variations. These different forms may be either open, as shown, or half blind, as shown in Lesson 27. The general method of working all the forms is the same, and may be understood by reviewing Lessons 26 and 27.

LESSON XXXVI

Miter Joint

The stock for this piece and the finished sizes are the same as for the halved corner (Lesson 16).

This form of joint, though often used, is too difficult for elementary work except in its most simple form.

The angle at which the ends are cut is exactly the diagonal of a square, and therefore any method that will give the diagonal of a square will give the line for the miter. The easiest way for the student in woodwork to get the correct angle is to draw a square at the end of the piece and then draw the diagonal as shown in Fig. 116 A. The point A is as far from the point C as the point B is from the point C, or the distance A C is equal to the width of the piece. When several miters are to be cut, the tee bevel (Fig. 116 B) may be set to the line A B and the other miter lines drawn with it.

In making miter-jointed frames, etc., take special care to have the face side and face edge straight, square, and out of wind, and then be particular to

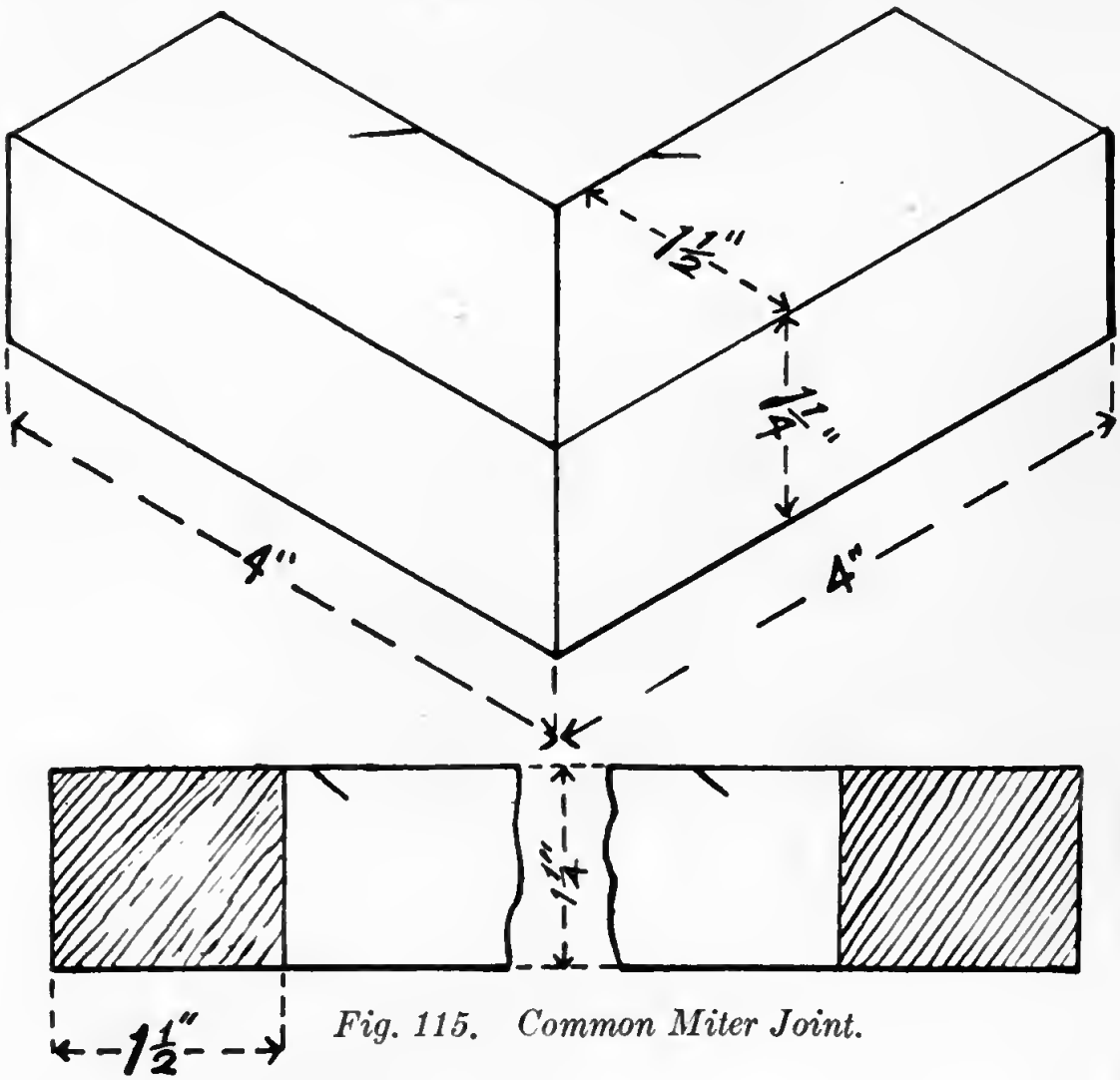


Fig. 115. Common Miter Joint.

draw all lines and make all tests from the face side or face edge. Saw the miter near the line and finish with a plane, as shown in Fig. 117. As the cut is not square across the end, the plane may cut all from one edge. Holding the plane at an angle, as shown in Fig 98, is sometimes necessary to avoid splitting at the extreme point.

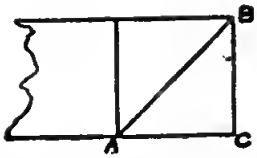


Fig. 116A.

Fig. 116B. Setting the Tee Bevel.

As the miter presents end grain, it is usual to nail the joint rather than to depend upon glue. If the joint is well sized as described in Lesson 31, the glue will aid much in holding the joint in place. If glue is used, before applying it start all the nails and drive them in sufficiently to make it easy to bring the joint to place after the glue is applied. Then separate the

Fig. 117. Planing a Miter in a Vise.

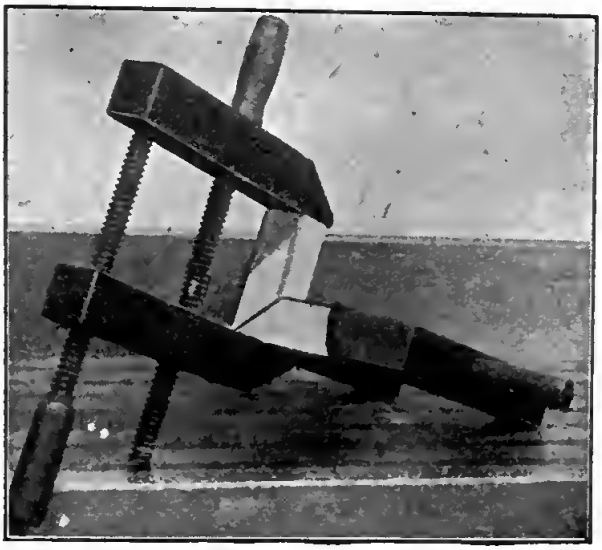


Fig. 118. Miter Joint Glued and Clamped.

parts and apply the glue. This joint may be clamped as shown in Fig. 118.

There are many ways of securing the corners of frames which are mitered. Some of these methods are very simple and easy when one has the special tools required to use them. There are some forms of special nails or fasteners which may be used by any one who is capable of fitting the joint.

LESSON XXXVII

Slip Mortise and Miter

The stock for this joint and the finished sizes are the same as for Lesson 19.

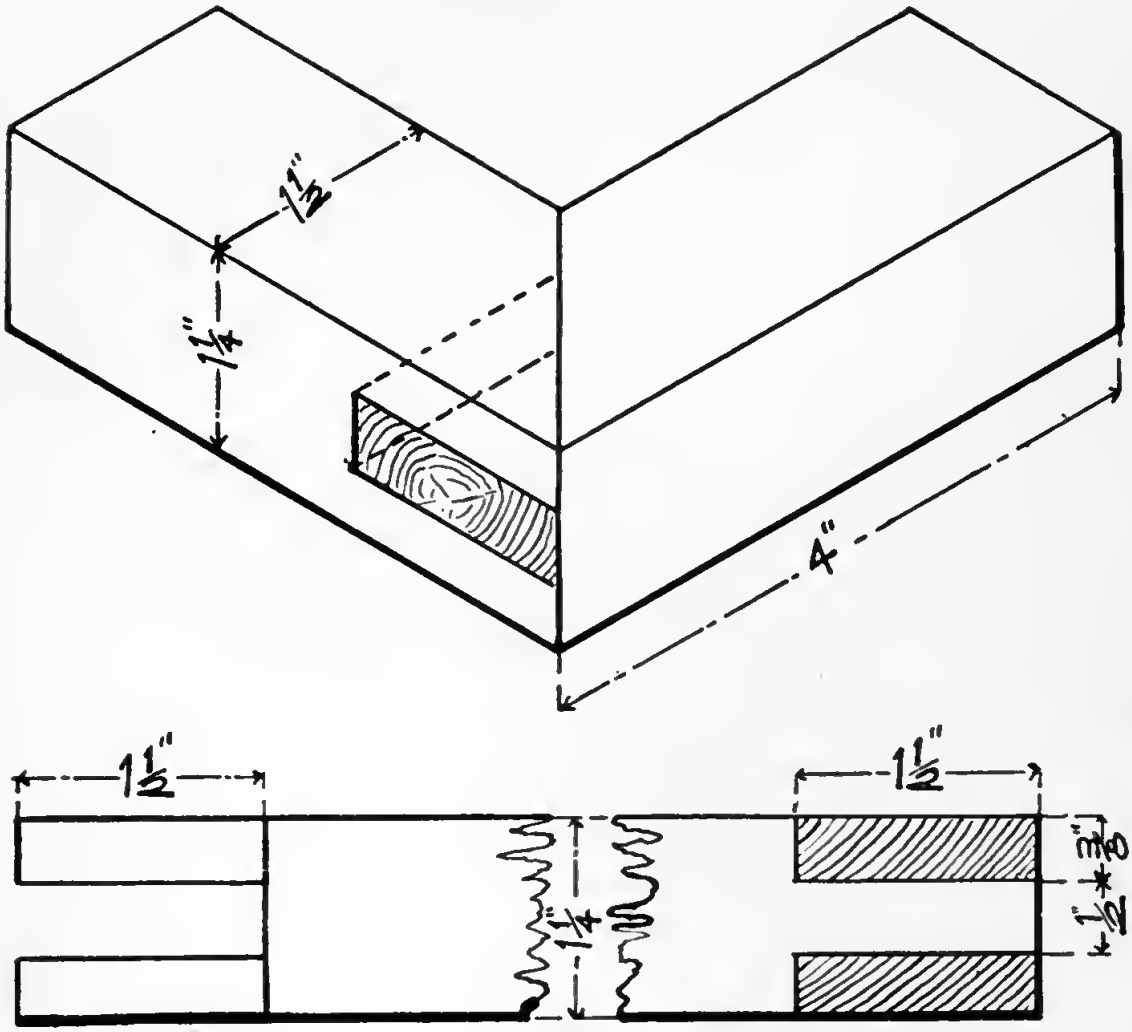


Fig. 119. Slip Mortise and Miter.

This joint is simply a combination of the joints shown in Figs. 70 and 115. By carefully reviewing Lessons 21 and 36 you should have no difficulty in making this joint. This joint should be thoroughly

clamped as shown in Figs. 77, 78, and 79. Place some paper between the blocks at the face and back of the joint to keep the glue which is forced from the joint from sticking the blocks or clamps to the joint.

This is a strong joint for frames, etc., but is not often used, because of the time required to make it.

LESSON XXXVIII

Glue Joint

It is often necessary to glue together narrow strips or boards to make one wide piece. This is not a very difficult operation if one has learned to control the plane properly. The first step is to select lumber suitable for such work and mark the sides which are to be the face of the finished piece. Also mark plainly the way of the grain, so that when the pieces are together they may all be planed from the same direction. (Fig. 120).

Examine the planes and be certain that they are sharp and not too much rounded, and that they will cut a shaving of good width but little thicker at the center than at the edges. The cutting edge should not be absolutely straight, neither should it be much curved.

Place one piece on edge in the vise and joint the edge carefully. Then lay it aside and joint the edge of the other piece which is to join the edge

first jointed. It is not necessary to use a try-square on these edges. They should be at right angles to the surface of the piece, yet if they vary a little it does not matter so long as they make a level joint, and the pieces do not slip sidewise in the clamps. In making a glue joint a regular mechanic would never think of using a try-square. When you think you have the second edge correct, set the first piece on it and test with a straight edge, as shown in Fig. 120, to see if the pieces will make a true surface. Next examine the joint carefully from both sides and ends, as shown in Fig. 121. Continue to plane and test the joint in this manner until it gives a true surface and the edges come in perfect contact the entire length. Pressing down upon the corners will help to show defective ends. Also try rapping the under board. There should not be the slightest opening at the extreme ends even if the ends are to be cut off in finishing the piece. When the joint is correct there will be a peculiar sensation of suction, or adhesion, as you gently push or pull the top board on the under one. Do not attempt to glue the joint until it is correct as shown by each of these tests. Always put the pieces into the clamps to see if they are all right before applying any glue.

Probably the most common errors in making glue joints are to suppose that the joint does not

require to be perfectly tight on the under or back side, and that dowels may be properly used in such joints.

If you are to use cold glue for the joint, be careful to have it sufficiently thin to soak well into the joint before putting together. Also have plenty

Fig. 120. Examining a Glue Joint with a Straight Edge.

of strong clamps. Allow the glue to become almost glazed before clamping the joint. Lay the clamps so that the joint will not be in wind, and use a sufficient number to expel every visible bit of glue as seen from the edge. The joint must be, in fact,

wood to wood if it is to hold properly. Equal care must be taken with hot glue, but less clamping will

Fig. 121. Examining a Glue Joint.

suffice to expel the surplus glue. In using hot glue you must be certain that everything is ready

for clamping before applying the glue. The clamps should all be in position and adjusted, so that the pieces may be put in place and the clamps tightened with the least possible loss of time. As hot glue will not hold if clamped too slowly, so cold glue will not hold if clamped too quickly. Considerable experience and judgment are required to get the best results with either. When properly used there is little if any difference in the holding power of the two kinds of glue. When the joint is poorly made the cold glue will hold better than the hot glue. With the inexperienced the additional time allowed in clamping the cold glue is quite an advantage. When much gluing is to be done, the hot glue is to be preferred because the piece may be taken from the clamps much sooner, thus saving a great deal of time and not requiring so many clamps. Care must be taken to keep the cold glue from becoming thick. The hot glue soon loses its strength by repeated heatings.

LESSON XXXIX

Making an Octagon

This exercise may be made from any defective piece of regular stock that will dress to at least 1 inch square and 1 foot long.

The piece should be exactly square and the ends exactly alike. Draw lines at each corner $\frac{3}{10}$ of the

total distance across the side from each edge. To get the distance at which to set the gauge, lay the rule on the piece at such an angle as will give 10

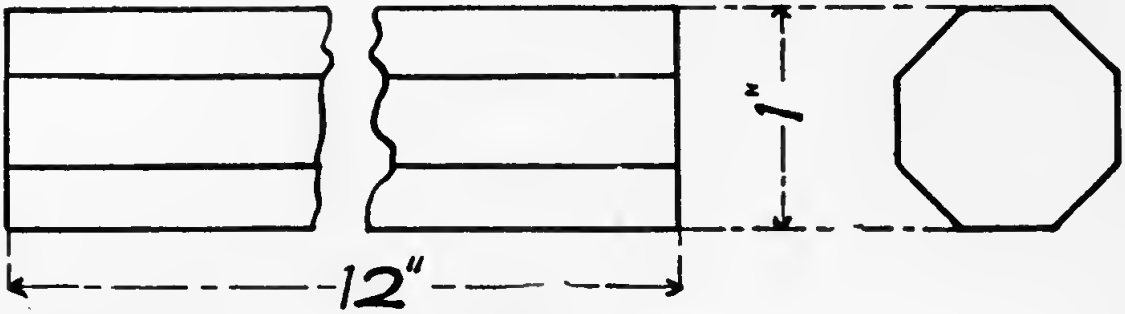


Fig. 122. Octagon.

equal divisions and mark off 3 of the 10 divisions as shown at A, Fig. 123. Set the gauge to this distance by placing the spur in the mark made by the knife point and moving the head up against the side of the piece. Draw the 8 lines, all equally distant from the four corners without regard to the face-marks. Draw the lines lightly, and be careful to leave the lines as you plane off the corners. If you wish to have a very nice piece of work, use a pencil point instead of the spur. (See Fig. 154.)

Fig. 123. Marking 3-10 with a Rule.

After planing the corners test each side at each end to see that all are equal. If you will mark each side with an X before planing the corners off you will have less difficulty in making the tests. On larger pieces you can take $\frac{7}{24}$ of the distance across the side instead of $\frac{3}{10}$. This is the distance used by carpenters in squaring timbers and is nearer the correct distance. In planing, the piece may be held in the vise (Fig. 124), or placed against the bench stop (Fig. 125).

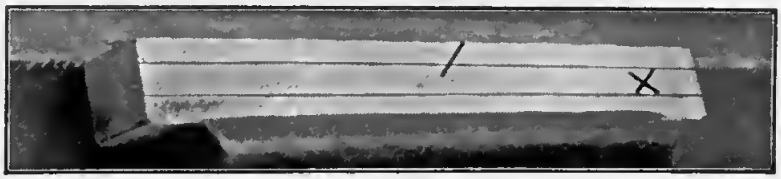


Fig. 124. Planing an Octagon in a Vise.

Fig. 125. Planing an Octagon Against a Bench-Stop.

LESSON XL

Making a Cylinder

Make an octagon as directed in Lesson 39. Be certain to have every side and angle correct. Any variation in the octagon is quite likely to show in the cylinder. Gauging the piece with the eye, plane off each corner, making the piece 16 sided. Then again plane each corner, making the piece 32 sided. Continue planing the corners, each time doubling the number of sides until the piece is practically cylindrical.

Fig. 126. Sandpapering a Cylinder.

With a half sheet of No. 2 sandpaper, used as shown in Fig. 126, remove all plane marks. Finish with finer grades of paper used in the same manner until the piece is smooth and cylindrical. Usually the piece is simply moved endwise in the bent, but not folded or broken, paper; but sometimes, when the piece is quite rough, it is first revolved and then finished by moving endwise. The piece should be often reversed and not sanded too much at the ends. When finished it should feel quite cylindrical when held in the hand.

LESSON XLI

Making a Pointer

Dress the two adjoining faces of a piece about 3 feet long and about $\frac{3}{4}$ of an inch square. Dress the third side, making the piece $\frac{3}{4}$ of an inch thick at the large end, and $\frac{3}{8}$ of an inch thick at the small end. Dress the fourth side, making the piece $\frac{3}{4}$ of an inch square at one end and $\frac{3}{8}$ of an inch square at the other end.

Lay off the piece at each end and at the middle for an octagon, as directed in Lesson 39, Fig. 123. Draw gauge lines at both ends and at the center about an inch long on all four sides. By the aid of these three sets of points or gauge lines plane off the corners, making the piece exactly eight-sided. Continue planing the corners, as in making the cylinder (Lesson 40), until the piece is substantially cylindrical. Finish with sandpaper in the same manner as you have finished the cylinder. This pointer should have two or three coats of shellac.

LESSON XLII

Making a Hexagon

Dress a piece to 1 inch by $1\frac{1}{6}$ inches wide. Draw lines at the centers of the 1-inch sides. Divide the other two sides into four parts and draw lines

parallel with the edges, omitting the center lines. Dress off the corners to these lines, making 6 equal sides.

This method appears to make the hexagon too large on one of its long diameters, but, as the tend-

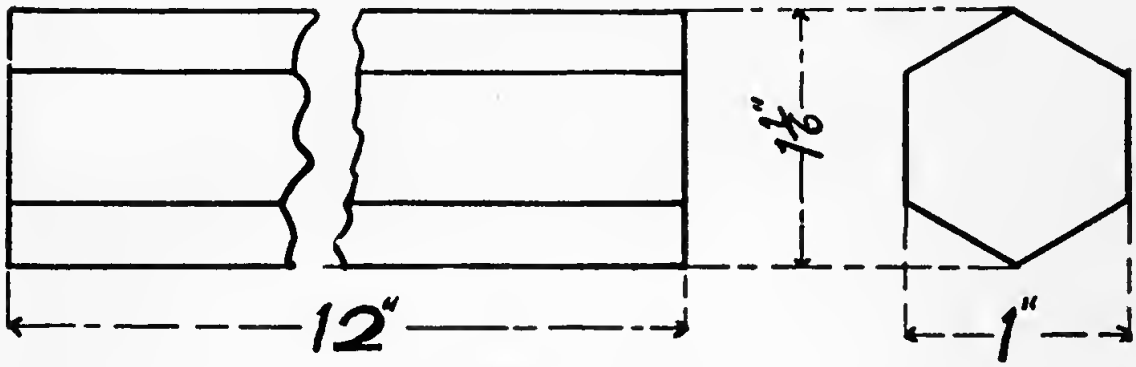


Fig. 127. Hexagon.

ency is to dress off a little too much at the ends of this diameter in planing the adjacent sides, the result will generally be a substantially correct hexagon. The piece should be carefully tested on all sides at each end with the rule.

PART III

Introduction

It is not the intention of the author to give in this part a catalogue of tools, but rather to illustrate and describe such few tools as may be required in these exercises. The information given is that which is thought to be of value to such pupils in elementary woodwork as will use this book.

There should be in every class room a complete catalogue of tools as furnished by some dealer. The more enterprising pupils will secure for themselves from the dealers such catalogues as will be of use. In some of these trade publications will be found the latest and most practical information on tools.

Some dealers will be pleased to furnish their retail catalogues free of charge; others have a fixed price which they charge except when the catalogue is sent out with a bill of tools. Every boy who is sufficiently enterprising to make good use of a catalogue will be able to secure one.

We wish to advise such boys or parents as will purchase individual sets for home use ever to bear in mind that nothing is gained by using a large variety of tools at the start. A few tools carefully selected and carefully and earnestly used will do far more good than is possible with a large number of tools at the start. The quality of tools should be

the best, which means that no fancy or combination tools should be purchased. Such tools have their place, but that place is not in the kit of the beginner.

Such appliances as miter boxes, expansion bits, molding or fancy planes, chisel grinders, spoke-shaves, wood files, and such tools should not be used in this grade of work. There are no doubt times when such things would be handy, but their presence in the boy's kit of tools at this time will do a great deal of harm.

APRON

Boy's Apron

For bench aprons for boys, get, according to the height of the boy, from $1\frac{1}{4}$ to $1\frac{1}{2}$ yards of blue and white plaid shirting or jumper cloth, or, if plain color is preferred, blue or brown denim or overall cloth. Fold the piece in the center lengthwise, and from one end cut out such a piece at one corner of the material as will leave, when the piece is unfolded, a bib at the center top eight or ten inches wide. The piece cut out should form a curve from the top of the bib to the edge of the material at the waist line.

Hem the bottom of the apron and the top of the bib with a wide hem and make a narrow hem around the curves. From the material cut away, make a strap of such length that when it is fastened at its ends to the corners of the bib it will pass easily over

the head. Also make straps to fasten at the lower ends of the curved portion and tie behind. No pockets are required and are a disadvantage, as they catch shavings and dirt. Figs. 31, 35, 52, and 86 show how such aprons appear when in use.

Girl's Apron

Any preferred material, such as gingham, calico, white or black goods, may be used for the girl's apron. Some very much prefer the yard-wide black mercerized goods, and in this width for medium height $4\frac{1}{2}$ yards will be required. For girls ten to twelve years of age 3 yards will ordinarily be sufficient.

Cut the apron sack front and back, open and hem the entire length at the back. Have the neck large enough to accommodate the neck dressing. The long sleeves should be gathered into tight bands fastened at the hand. A broad band fastened on the side seam at the waist line and buttoned at the seam on the opposite side will hold any fullness from falling forward. Buttons and button holes should be placed at the top and center of the back and at the waist line. No pockets are required in this apron. Figs. 71, 98, and 104 show various styles of aprons in use.

Bench

The woodworker should take pride in keeping his bench in order. The bench-board or bench-hook should be used to avoid injuring the bench. Never should the knife or any other tool be stuck in the bench top. In starting nails be careful not to drive them through into the bench. Boring must be done in the vise or on a board or the bench-hook in order to avoid making holes in the bench.

Once each week the top should be thoroughly rubbed with oily waste. The drawers should be kept clean and each tool in its place. To avoid the necessity of frequent cleaning, do not allow them to remain open. The vise must not be overstrained. Remember that there is a limit to what it will bear.

Keep on the bench only such tools as are in use. At the close of each recitation put all in order. Do not wait until the close of the recitation to put away tools that will not be needed again during the recitation, but when done with them put them away at once.

Do not loan any tools from your bench without special permission. Your bench should be securely fastened to the floor. If it becomes loose, make a report to the instructor.

Bench Stop

There are many styles of bench stops from the simple square wooden pins to the adjustable and reversible iron stops. One style of iron stop is shown in Fig. 128. Do not think because the stop is made of wood that it does not matter how it is used. The more particular you are to keep the stop in order and at the proper height, the faster you will be able to work. See that the stop is enough above the top of the bench to hold firmly, and keep in mind that many irons tops have a tendency to split the end of the piece. Sometimes when the piece is crossgrained the stop will split a corner or edge entirely off. It is seldom or never best to use a hammer or mallet or anything else with which to drive the piece against the stop. It is not necessary for most work that the piece stick to the stop.

Fig. 128. Bench-Stop.

In using the adjustable stop be careful not to strain the adjusting screw. Turn it but a very little either way. You will observe that the stop will stay in place even though the adjusting screw is tightened but a very little. Be sure to have the stop sufficiently low to avoid hitting it with the planes.

Bits

Of the several kinds of bits the auger bit shown in Fig. 129 is best adapted for general use. These bits are usually had in sets of thirteen, varying by sixteenths in size from one-fourth inch to one inch, The boxes usually have a place for a three-sixteenths size, and for small work this size is quite useful. Auger bits vary greatly in price. The best are the cheapest in the end.

Do not attempt to sharpen your bits until you have had personal directions for doing such work. A good bit is easily spoiled by a little improper

Fig. 129. Auger Bit. A, Nibs; B, Spur; C, Lips.

Fig 130. Forstner Bit.

Fig. 131. Twist Drill.

filing. Never use a good auger bit when there is any liability of its coming in contact with a nail or a bit of sand or grit.

The Forstner bits are exceptionally useful in boring end grain. They make smooth holes and do not split the wood. Fig. 130 illustrates one of these bits.

There are many other styles of bits. The twist drill shown in Fig. 131 is especially useful in repair work as it is not injured by coming in contact with nails. These drills are quite hard and may be used in drilling metal. They are very easily broken and

must not be used except where they can be held firmly and kept from binding. The work should be so firmly held that the drill will not be broken in withdrawing from the hole or by the piece moving while drilling.

The twist bit (Fig. 132) is similar to the twist drill but not so hard and consequently not so easily

Fig. 132.
Twist Bit.

Fig. 133.
Gimlet Bit

Fig. 134.
German Bit.

broken. It is not hard enough to drill nails without injury. It is useful in boring deep holes for screws.

The gimlet bit is tapering as shown in Fig. 133 and is a good shape for boring holes for short, blunt screws.

The German bit is also a good bit for boring small holes. You see by referring to Fig. 134 that this bit has but a single twist and therefore presents a sharper edge to the wood than the common gimlet bit.

Fig. 135.
Center Bit.

Fig. 135 is of a center bit, a very cheap bit and a good bit for rough work and for boring soft wood. Such bits are easily sharpened and are used by many where an auger bit might be spoiled.

Bit-Brace

The bit-brace, which is used to hold the auger bits, screw driver bits, countersinks, etc., consists of a chuck Fig. 136, a knob, and a handle, or sweep. The chuck is made to grasp the square shank of the bit by revolving the sleeve which forces the jaws against the bit.

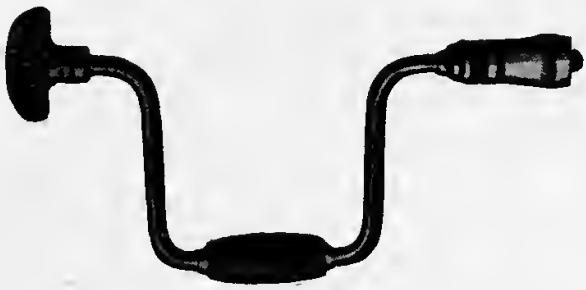


Fig. 136. Plain Bit Brace.

Some bit-braces are quite expensive, yet the more simple styles are the best for ordinary work. The ratchet brace shown in Fig. 137 is convenient for use in places where the sweep cannot make an entire revolution, and for boring in hard wood and for turning large screws.

To insert the bit, grasp the sleeve firmly with one hand and revolve the brace by grasping the sweep handle with the other hand. Revolve the brace until the shank of the bit will pass between the jaws, allowing the ends of the jaws to grasp the round part of the bit shank, the square portion passing into the chuck out of sight. After the bit has been placed

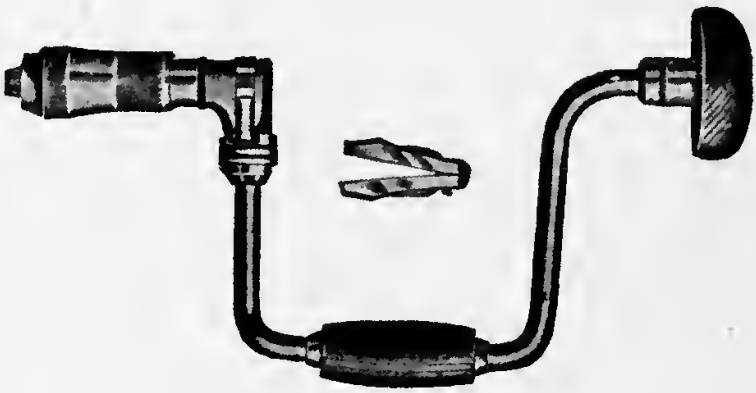


Fig. 137. Ratchet Bit Brace.

as far into the jaws of the chuck as it will go, revolve the sweep in the opposite direction until the bit is held firmly.

Brushes

For use in shellac and in the common paint stains a flat brush one inch wide, costing from five to fifteen cents, will be sufficient (Fig. 138). Small round brushes having stiff bristles may be used in the glue (Fig. 139), but for most gluing a small wooden paddle is sufficient. It is usually best to keep the shellac brush in the dish of shellac. The handle of the brush should project up through the cover of the can as shown in Fig 201. Do not use a dish having a tall cover for keeping the brush inside. Be very careful always to cover the dish when not in use even though it will be again used in a very few minutes.

Fig. 138. Flat Brush.

Fig. 139. Round Brush.

The brush and dish should be emptied and cleaned frequently. The dish used should be small, and but a little shellac kept in it at one time. When the brush or dish becomes dry and hard it should be thoroughly cleaned before using again. It is a bad practice to allow the brush to become dry and hard by leaving it out of the dish each time after using.

Chisels

The common firmer chisel (Fig. 140), the bevel-backed firmer chisel (Fig. 141), and the heavy firmer chisel (Fig. 142) represent the general types of hand chisels suitable for elementary woodwork. Where but one style can be had the first is preferred. Either style may have either tanged blades, as shown in Figs. 140 and 141, or socket blades, as shown in Fig. 142. The tanged blades are better for small hands and for light work.

Fig. 140.
Plain Tanged Firmer Chisel.

Fig. 141. Bevel Tanged Firmer Chisel.

Keep the chisels sharp. The angle of the basil side should be as small as possible to not break when in use. This angle can be determined only by experiment for each person and for the various kinds of wood. The cutting edge should usually be straight and the basil a smooth, even surface, as shown in Fig. 143.

Fig 142. Socket Firmer Chisel.

When the chisel is sharpened on the oil stone, a new angle is formed, as shown by the line B in Fig. 143. This angle also varies with the nature of the tool and work. For soft wood the angle is smaller

than for hard wood, and usually each time the chisel is sharpened on the oilstone the end will become more blunt until it is necessary to change the angle by grinding the tool on the grindstone.

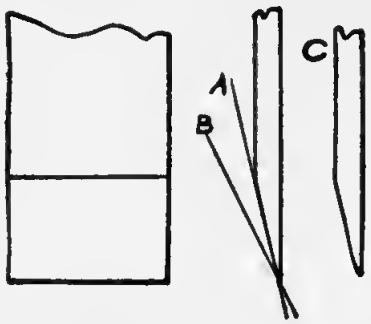


Fig. 143. Chisel Basil. A, Angle at which the chisel is ground. B, Angle at which the chisel is whet. C, Incorrect shape caused by carelessness in whetting or grinding.

In whetting the chisel hold it firmly as in whetting the plane, Fig. 175. Move it back and forth so that the angle produced will be even and flat. The common mistake in whetting chisels and planes is to make the end rounding as shown at C, instead of a true flat surface, Fig. 143. Should a wire edge develop it may be necessary to reverse the chisel, as shown in Fig. 144, and holding it firmly and flat on the oilstone move it forward, breaking off the wire edge. It may be necessary to change from the first to the second position several times before the wire edge will be removed. After using the oilstone the edge may be yet further improved by using a leather strop, as shown in Fig. 202.

Fig. 144. Removing a Wire Edge.

One side of the chisel should be kept perfectly flat to the cutting edge so that it may rest firmly against the surface of the part being worked, as in Figs. 39, 40, 43, 53, 73, etc. Should this side become rounding, either from wear or from carelessness in whetting or stroping, the end must be ground off on the grindstone until the surface is straight.

For directions about grinding chisels, see what is said about the grindstone and its use.

Clamps.

Probably the old-fashioned wooden hand screws shown in Fig. 145 will never be entirely displaced. For most work they are better than any other style.

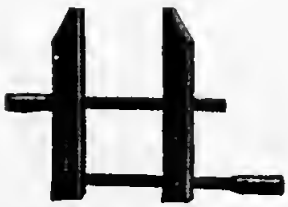


Fig. 145. Wooden Hand Screw.

Care must be taken to keep the jaws quite or nearly parallel, for if they are not parallel one or both of the screws may be broken.

In using them first tighten the screw which is nearest the center of the jaws. This screw is called the shoulder screw. The other screw near the end of the jaws is called the back or tail screw and is tightened last. Be sure that the shoulder screw is so tight that when the back screw is tightened the jaws will be parallel. Be very particular to see just how the jaws are pressing on the work. This may sometimes be determined by grasping the back screw between the jaws and pulling sidewise. The

point on which the jaws turn is the point of greatest pressure. Sometimes it is necessary to use wedges between the work and the clamp.

The iron clamp shown in Fig. 146 is better for some places than the wooden hand screws. These clamps are made in a variety of styles. Some are supplied with quick adjusting devices. They all require wooden blocks to be placed between them and finished surfaces. For some work this is quiet troublesome.

Fig. 146. Iron Clamp.

For clamping glue joints a very strong clamp is necessary. The one shown in Fig. 147 is a very good style. Common iron bench screws may be secured to a similar piece and when properly fastened make excellent clamps. Whatever style of clamp you are using, remember that it may be overstrained or broken. A little experience and use of judgment will enable you to know when the strain has reached the limit of safety. Do not be afraid of using too many clamps on work that requires great pressure. Some pieces are best clamped by using as many clamps as may be placed in position on the piece. For directions in clamping see Figs. 58, 77, 78, 79, 118.

Fig. 147. Bar Clamp.

Compasses

Fig. 148 illustrates the common compasses used by woodworkers. Fig. 99 shows a method of setting them, and Fig. 100 shows how to hold them in striking a circle.

Fig. 148. Compasses.

The ordinary difficulty in using compasses is to overstrain the adjusting screws or to grasp the compasses in such a manner that the distance between the points is changed by the pressure of the fingers. Hold them nearly vertical and revolve them in either direction according to the grain of the wood or the position of the circle.

For most work it is better to sharpen the end of one leg of the compasses to a rather blunt round point and the end of the other leg to a flat knife-like point.

Do not use compasses to pry with, to make holes for screws, or for similar uses. Do not strike them on the top end with the hammer or use the hammer claws to turn the screws.

Files

Two files may be required by the beginner, an eight inch flat mill file and a three inch three cornered taper saw file.

The mill file (Fig. 149) will be used in sharpening

compasses, the gauge spur, and similar work. The saw file (Fig. 150) will be used for filing saws.

Files are so shaped that the teeth cut but one way, and therefore they should be pressed against the work only on the forward stroke. When learning to use a file, it is better to lift it entirely from the work on the return stroke. Always hold the file firmly and move it as nearly the entire length as the work will permit. In filing saws or any light, thin material, be very careful to have the work held firmly. For ordinary work the file is moved lengthwise, but sometimes it is moved sidewise, as in sharpening the scraper (Fig. 186).

Fig. 149. Mill File.

Fig. 150. Taper Saw File.

Gauge

In selecting a gauge the inexperienced are apt to select the more expensive styles, thinking they will be able to do better work with the higher priced tool. Taking every condition into account, the plain beechwood gauge (Fig. 151) with a boxwood screw and bar ungraduated is the best for the beginner as well as for the matured mechanic for most work. This gauge is light and strong, and as there is no brass on the face of the head, it is very easily planed smooth and straight when it wears uneven. It will keep in shape

Fig. 151. Plain Gauge.

longer than some which have the brass facing. In no case should one depend upon the graduations upon the gauge-beam, but use the rule as explained in Lesson 3.

In advanced work and for use in projects where many mortises of the same width are to be made, a mortising gauge may be used to good advantage.

Fig. 152. Mortising Gauge.

For all elementary work and for most other work the plain gauge is far better. The mortising gauge (Fig. 152) has two spurs on one side at one end so that the lines for both sides of a tenon or mortise may be drawn at the same time. There is also a single spur at the opposite side of the beam, that the gauge may be used for drawing a single line.

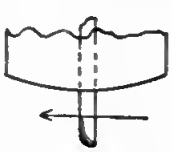
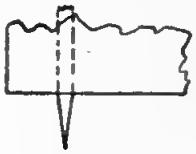


Fig. 153.



Gauge Spur.

The spur on all the gauges should be sharpened with a file to a sharp, flat, wedge-like point. The point should be a little rounded on the end, making the edge which is in front as the gauge is used a little the shorter. When properly sharpened and used it will make a neat, fine line. Fig. 153 indicates the shape of such a spur. The spur should extend at least an eighth of an inch from the lower surface of the bar, and for most work three-sixteenths of an inch is better. It should be out so far that the beam of the gauge will never be flat against the piece which is being lined.

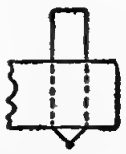


Fig. 154. Pencil in Gauge Bar.

It is sometimes convenient to have a lead pencil gauge line. This is easily accomplished by boring a hole through the gauge beam near one end and inserting the stub of a lead pencil. The pencil must have a very blunt point, as shown in Fig. 154.

When much thin lumber is to be worked, a splitting spur may be placed in the opposite end of the beam. Such a spur should split pine or basswood boards up to one-fourth inch in thickness. The spur may be made from the broken end of a knife blade as shown in Fig. 155. Before trying to split a piece, joint it carefully and then use the splitting gauge on both sides of the piece.

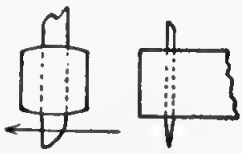


Fig. 155. Splitting Spur.

Glue

For elementary work use nothing but the best grade of prepared cold glue. Do not use it from a large dish or from the can in which it is sold. It may be used from a small bottle having a wide opening like a paste bottle. This bottle may be kept covered with a bit of paper or with the regular screw cover. A better plan is to place a small dish in a larger dish or box and fill the larger dish to near the top of the inner one with plaster of paris. This will keep the brush moist and keep the glue from drying if a little water is poured on the plaster

of paris often enough to keep it moist. The dish may have a loose or hinged cover of either wood or metal.

For most purposes in applying the glue a flat stick is better than a brush. In case the glue becomes too thick add a little water. This should be added some time before the glue is to be used that it may become well mixed with the glue.

For directions in applying and using the glue see Lesson 16, Fig. 58, Lesson 21, Figs. 77, 78, and 79. Glue sizing is explained in Lessons 31 and 34 and making glue joints is explained in Lesson 38. If you have purchased a good quality of glue, do not blame the glue if it does not hold. Go over the directions carefully, remembering that the reason for the trouble may be in your not following some part of the directions which you think of no consequence, but which may be the whole cause of the trouble.

Grindstone

After edge tools have been whetted several times the cutting edge becomes so blunt that it is necessary to remove a considerable portion of the end in order to maintain the proper cutting angle. This is accomplished by using a grindstone or emery grinder suitable for this sort of grinding. Grindstones are not likely to injure the tools if properly

supplied with water. Emery wheels are often so hard, and run at such a speed that they will spoil the tools unless one understands thoroughly how to use them.

Ordinary grindstones are cut from natural sandstone. They vary greatly in quality. Some are much harder than others. Some are composed of particles of sand which are quite hard and sharp while others do not have this keen cutting quality. All wear more or less uneven by use and it is therefore necessary to be careful in using them. Always try to grind down the high places and in grinding small tools such as narrow chisels and gouges you must keep them moving across the face of the stone.

Fig. 156. Grinding.

If the grindstone were in perfect condition there would be little trouble about grinding tools. This however is almost never the case and you must there-

fore learn to grind on grindstones that are very much out of order. This is not so difficult a task as you may suppose. The best way is to learn to hold the tools freehand as shown in Fig. 156. This does not require a great amount of practice and when once learned will enable you to grind on almost any grindstone in a very satisfactory manner.

Be careful to hold the tools firmly and at the proper angle. Grind back from the edge first and finish by grinding at the edge until the basil surface is straight, flat, and to an edge. The flow of water will help to indicate how the stone is cutting. The stone or emery wheel should revolve towards the edge of the tools as indicated by the arrow. One hand presses the tool to the stone and the other hand controls the angle. The motion of the stone has a tendency to roll the chisel or plane bit in such a manner that it will be cut too much at the upper corner. The hand which controls the tool must tend to roll it so it will tend to cut most at the lower corner. Grind very carefully and examine the tool often to see just how the stone is grinding. You must not expect to grind the edges of chisels, planes, and similar tools sufficiently fine for use. The grindstone is to remove the large quantity of material and give the proper shape and angle to the basil surface. The whetstone and strop must be used to produce the keen cutting edge.

The directions for whetting chisels and planes are given under the descriptions of these tools.

Hammer

Fig. 157 illustrates a carpenter's plain faced hammer. Fig. 158 illustrates a carpenter's bell faced hammer. The plain faced hammers are used on ordinary work and are better for the use of beginners. The face of the bell faced hammer is rounded and is much more difficult to use except when one is constantly in practice with it.

Fig. 157. Plain Faced Hammer.

Hammers are made in many styles and sizes. The number two, weighing thirteen ounces, is a good size for boys. The correct position for using in the ordinary work of driving nails is shown in Fig. 25. There are times when the handle should be grasped quite near the head.

Although the face of the hammer is of hardened steel, yet it may be injured by striking the ends of files or other very hard bits of metal. The most common injury is to the claws by wedging nails between them so tightly that the thin sharp edges of the claws are injured. The ends of the claws may be broken. Sometimes a block is used under the hammer head as shown in Fig. 29. Probably the

Fig. 158. Bell Faced Hammer.

most needless and foolish injury to hammers is done by striking them on the side of the head instead of on the face in ordinary hammering. There are times when the side of the hammer may be used, but it should not be, when the face can be used.

Should you wish to work in metals do not use your carpenter's hammer, but rather use a hammer similar to those shown in Figs. 159 and 160. These hammers have the weight of metal distributed in a different manner and will give a very different effect to the blow.

Fig. 159. Riveting Hammer.

If you will carefully watch the effect of the blows given by different hammers and the same hammer held or used in different ways, you will learn why one hammer can be made to drive a nail which another hammer will bend over and why one person can drive a nail into a piece of hard wood while others can not. These are matters of very much importance which can be learned only by careful study, experiment, and observation.

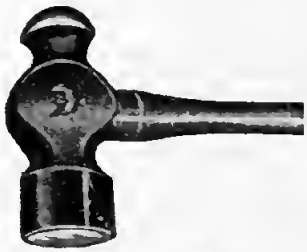


Fig. 160. Machinists Hammer.

Knife

Do not try to economize by using a poor knife. Only one that may be kept in first class condition should be tolerated. The knife should have two blades—one at each end. The smaller blade is to be used for drawing lines and the point of this blade must be kept very sharp. Knives with many blades or with tools in their handles should not be used. Neither should you try to use a knife having a chain attached to the handle.

Fig. 161. Pocket Knife.

Always keep your knife sharp. Fig. 161 illustrates a well shaped knife.

For directions in using the knife see Lessons 6, 8, 16, 18, 20, 21 and Figs. 18, 19, 20, 21, 22, 32, 33, 42, 65, 92, 113. Be very particular to use your knife as directed, for very much depends upon making a straight, clean and correct line.

Lumber

The materials for these exercises may be of any easily worked soft wood. Probably white pine is the best. Basswood and whitewood or yellow poplar are also suitable. Black walnut and mahogany are good but expensive. Maple, oak, and ash are too hard. Chestnut and hard or yellow pine have a grain which is unsuitable for joinery.

Always examine your material for defects and plan your work so that the defects will be cut out or covered up. Notice carefully the difference in texture of different pieces and the different parts of the same piece.

You will not work enough pieces nor pieces large enough to give you very definite information, but if you will observe each piece carefully you will gather a fund of information which will aid you very much later on. Your principal study will be to learn how to discover the way of the grain, and how to plane and cut joints smoothly in cross grained pieces. This you will learn by experiment. Some pieces cannot be worked smoothly either way, but will generally work much smoother in one direction than in the opposite direction.

Notice also that certain parts of a piece require a much sharper tool than do other parts. Learn to distinguish pieces that will work easily and smoothly so that you can select the proper stock for fine work and also use pieces for rough jobs which will not work smoothly. You must learn to make these selections without testing them with the tools.

Nails and Brads

Very little need be said about brads and nails. They are made in such a great variety that it is scarcely possible to have use for any form or size

which is not for sale by some dealer. Each dealer will have a number of styles and sizes suitable for his own trade, and from these you should make your selection. It is best to become somewhat acquainted with what may be purchased in your own locality before planning any project that will require any hardware beyond the most common grades. This caution is nearly as necessary for those living in cities as for those living in small towns.

There are nails with flat heads in very small sizes. For some work these are better than brads as the heads will not pull through soft wood. Some of these nails are rough or barbed on the lower end or the entire length as shown in Fig. 162-A. These are desirable for nailing such work as the shelf border in lesson 12.

Fig. 162A. Barbed Nail.

Brads are made in many lengths, and the different lengths are made with different size heads and of different size wire. The larger sizes of this style of nails or brads are called finishing nails. Nails having a smaller size of wire than the common wire nails but a similar head are called box nails. These are very useful in making boxes and in fitting up about the shop.

Fig. 162B. Fancy Nails.

Sometimes you will find it a good plan to fasten the work together with common brads or nails, and then cover these nail heads with the large heads of fancy nails like those shown in Fig. 162-B. These

fancy nails are made in a very great variety of sizes and styles. They may be used in finishing the shelf border, lesson 12.

Nail Sets

There are several varieties of nail sets, of which the cup set and spur set are most common. The cup set (Fig. 163 A) has a cup-like cavity at the lower end to set over the head of the nail or brad. This style is excellent for very small brads. The spur set (Fig. 163 B) has a small point at the center of the

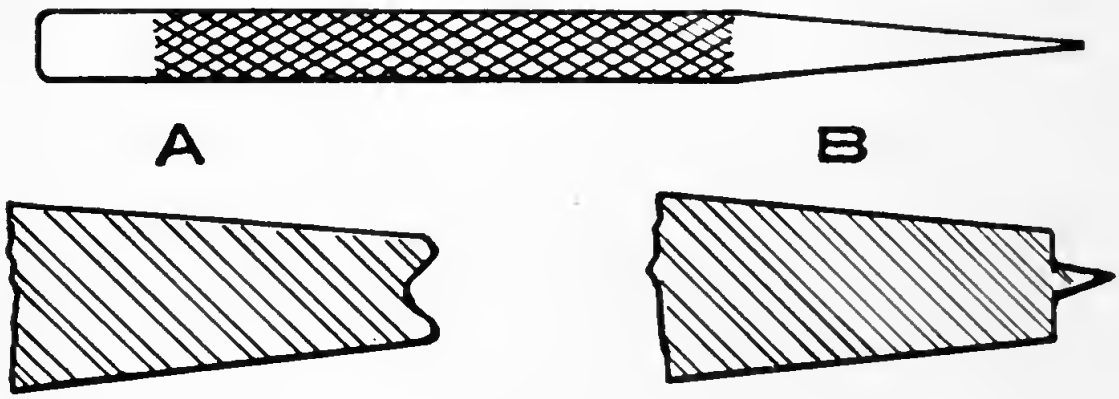


Fig. 163. Nail Set. A—Section of a cup set, enlarged. B—Section of a spur set, enlarged.

lower end. This point is quite small, but sufficiently large to keep the set from slipping off the nail head. The spur set is better for large brads and nails. Be careful to use a set of the proper size to correspond with the brad or nail on which it is to be used. The method of using the sets is shown in Fig. 27. Frequently the head of a brad or nail may be used instead of a nail set, as shown in Fig. 28.

Oil Can

One is apt in selecting an oil can to think that the more expensive sorts are the best. This is not always the case. For use on the bench, when oil is used only for oilstones, a very small and light can is better than a large heavy one. A can a little larger than those usually furnished with sewing machines is a good size. The hole in the spout should be quite small. It is far easier to take the necessary time to let oil flow from a small opening than to wipe up the excess which is sure to flow from a large spout with a large opening. Neatness and economy in the use of oil will help one to become neat and economical in the use of other materials. Be very careful in filling the can not to get any dirt into it, for a very small bit of dirt may stop the spout and cause a good bit of trouble.

Oilstone

There are many kinds of oilstones. Some are pieces cut from natural rock and some are made by pressing a powdered abrasive into a rectangular block. Most stones used for sharpening edge tools are used with oil and are called oilstones.

The oil keeps the particles of metal from adhering to the surface of the stone, or, as we commonly say, keeps the surface from glazing over. Do not

use too much oil, only enough to keep the surface well moistened. Oil should not run over the ends or edges. Some oilstones work very much better after being well filled or soaked in oil. It is often better with a new stone not to wipe the oil off after using it. Wipe it only when the surface becomes dirty or filled with metal. Lard oil or other animal oils are better than mineral oils for use on oil stones. Some dealers sell oils especially for use on their oilstones.

It is a good idea to keep the stone in an iron box as shown in Fig. 144, or in a wooden box. Some prefer to keep the stone in the pasteboard box in which it is purchased, and hold it in the vise while using it, as shown in Fig. 175.

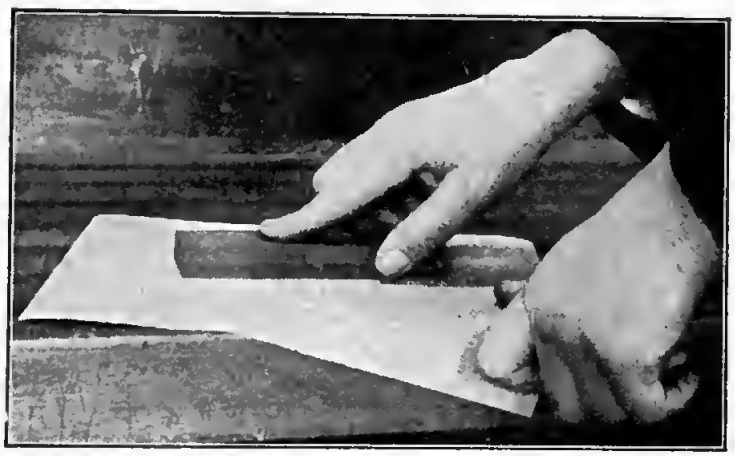


Fig. 164. Truing the Surface of an Oilstone.

The surfaces of oilstones may be made flat by rubbing them on a sheet of sandpaper or emery cloth laid on the bench, or on a smooth flat board as shown in Fig. 164. If you are careful to rub the plane bits and chisels the entire length of the stone, and to sharpen knives and small tools near the ends of the stone, it will keep in good shape for a long time. Most oilstones will break easily and must be handled with care.

There are many ways of testing the edges of tools to see if they are sharp. Probably the best method is to use the ball of the thumb as shown in Fig. 165. Another very good test is to try the tool on a scrap of pine. The smoothness and glossiness of the surface of the cut will indicate very well the condition of the cutting edge. You should learn to test the edge with your thumb, because it is quicker and better for most purposes.

Fig. 165. Testing an Edge with the Thumb.

Pencil

A common pencil, such as is used in writing, is sufficient for ordinary work. If there is much lining to be done on large or rough stock, a carpenter's pencil which has a wide flat lead should be used. The point need not be as sharp for writing on wood as for writing on paper. By pressing quite firmly

the writing will be pressed below the surface so that in sanding for the second coat of finish the writing will not be removed. If you desire to have lines which you can erase, use a soft pencil with a blunt point.

For erasing pencil lines use a common pencil eraser. Do not attempt to erase pencil lines by using sandpaper.

Planes

Although there are many sorts and sizes of planes, yet for most work two or three planes are sufficient. For the exercises in this book two planes are all that are necessary. If we do the work with only two planes we will likely receive more benefit and lay a better foundation for future work than if we should use a larger number of planes at the start.

Fig. 166A. Iron Smooth Plane.

These two planes are the smooth plane (Fig.

Fig. 166B. Iron Jack Plane.

166A) and the jack plane (Fig. 166B). It is not essential which plane is used at first for planing the first piece. You will select the one which best suits your strength. After you have had some practice, you will likely prefer the longer or jack plane for rough planing, and the smooth plane for finishing and planing ends and miters. To do nice work on long pieces the jack plane should be set fine and used instead of the smooth plane. As you become more skilled in the use of the planes, you will keep them ground nearer straight across, and will change the set more often to accommodate them to the various kinds of work.

Fig. 167A. Wooden Bottomed Iron Smooth Plane.

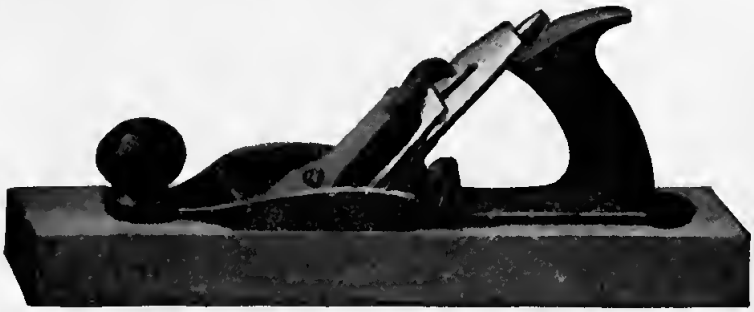


Fig. 167B. Wooden Bottomed Iron Jack Plane.

The wooden planes (Figs. 168 and 170) have been nearly displaced by the iron planes. The wooden bottom iron planes (Figs. 167A and 167B) are preferred by many workmen for use on soft wood. The beginner will undoubtedly have better success with the full iron plane. The iron planes are used rather because they are more easily adjusted and more easily kept in order than because they are capable of giving

any better results on ordinary work. Fig. 168 shows the proper position for holding the wooden jack plane.

Fig. 168. Using the Wooden Jack Plane

Adjusting the Planes

There are various ways of adjusting iron planes. To make the plane cut a thicker or thinner shaving the milled thumb-screw A (Fig. 169) is turned. The proper way to turn it must be learned by experiment, as it is not turned the same way in different styles of planes. Remember that there is often a considerable lost motion in the screw and lever, so that the screw must be turned a little before it will have any effect in changing the thickness of the shaving.

Fig 169. Sighting the Bottom of the Iron Plane.

In your first experiments at setting the plane, turn the screw so that the plane will not cut at all and then turn it in the opposite direction, testing

it on a bit of waste material to see when it is cutting properly. Turn the screw but a little at a time, testing it often on the piece of waste and also each

Fig. 170. Sighting the Bottom of the Wooden Plane.

time hold it as shown at Fig. 169 or 170, sighting lengthwise of the bottom or sole of the plane. You will soon be able to see how much the cutting edge

projects from the surface so that you can set the plane without using the piece of wood for testing it.

As soon as the plane cuts at all look carefully

Fig. 171. Withdrawing the Plane Iron of the Wooden Plane.

to see whether it is cutting the shaving at the center or near one edge. If the shaving does not come up at the center of the plane, move the lever B

(Fig. 169) sidewise until it does. If there is no lever for moving the bit sidewise you must strike the side of the bit near the top end with a hammer as in adjusting the wooden plane (Fig. 170).

Sometimes the bit does not stay in place after being adjusted. This may be caused by carelessness in handling, or the screw (Fig. 173 S) may be loose. This screw should be so adjusted that when the cam lever (Fig. 173) is down the bit will be held firmly in place.

The wooden bottom iron planes are adjusted in the same manner as the iron planes. The wooden planes are adjusted entirely with a hammer. To withdraw the iron, the plane is struck with a hammer on the top near the front end as shown in Fig. 171. Strike the iron a light blow on the upper end to increase the thickness of the shaving. When the bottom of the wooden plane or the wooden-bottom iron plane becomes worn out of true, draw the iron well out of the way and dress the bottom of the plane, as shown in Fig. 172. This figure shows an iron jointer plane in use, but the work may be well done by using a good iron jack plane.

Fig. 172. Jointing the Bottom of a Wooden Plane.

Sharpening Planes

Your planes should be sharp and ready for use when you get them and you should become quite familiar with these tools and be able to set them nicely before attempting to sharpen them in any manner.

Fig. 173. Lifting the Cam Lever. S—The screw which holds the cap and iron in place.

The first step in sharpening is to learn to whet the bits on the oilstone. To remove the bit, grasp the cam lever as shown in Fig. 173 with the thumb and finger and lift it upwards. This will loosen the bit. Be very careful to see and remember just how every part appears when in proper position. Lift the loosened parts from the plane and with a screwdriver loosen the screw as shown in Fig. 174. Either remove the cap iron or slide it to the top end out of the way.

Observe carefully the angle at which the iron has been ground and hold it on the oilstone so that the oilstone will make a slightly blunter angle, as shown in Fig. 143, A being the angle at which the

Fig. 174. Loosening the Cap Screw.

iron was ground, and B the angle at which the iron is to be whetted. Use a sufficient amount of oil on the stone to cause it to cut freely. Rub the bit forwards and backwards, keeping it at the same angle. Hold the bit very firm as shown in Fig. 175. As you become more accustomed to using the oil-stone you will give the tools a somewhat circular motion, varying the amount according to circumstances. There are a great variety of motions which may properly be used and which by practice you will discover. You should use only a simple forward and backward movement at first. The essential points which must ever be kept in mind

Fig. 175. Whetting a Plane Bit. A chisel is whetted in a similar manner.

are to use the stone over its entire surface so that it will wear down evenly, and to keep the plane bit at the same angle during the entire process of whetting so that the surface will be definite and not rounded in the least as examined from the edge, the same as the chisel (Fig. 143, B and C).

There is always a tendency to whet the corners short, making the cutting edge rounding as shown in Fig. 176. This will do no harm if not too much. In fact, for beginners it is better to have at least one of the planes, usually the jack plane, quite rounding so that it will cut only a narrow shaving and consequently not require so much strength to use it. As you become more skillful in using the planes you may whet them more nearly straight across until they are almost straight except very near the corners.

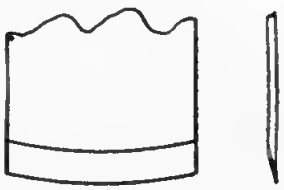


Fig. 176. Rounded End of a Plane Iron.

After bringing the bit to an edge it is often necessary to turn the bit over and lay it flat on the oilstone to remove the wire edge, as in sharpening the chisel (Fig. 144). Generally it is necessary to reverse the bit several times before the rough edge will come off. After the wire edge has been removed the bit should be stropped on a bit of leather as the chisel is stropped (Fig. 202).

Replace the cap iron, bringing it to about one thirty-second of an inch from the cutting

edge, and tighten the screw. Place the parts in the plane and adjust them as described on page 168.

After the plane bits have been whetted several times they should be ground as described in the general directions for grinding under the topic *Grindstone*.

Putty

Good putty consists of whiting and linseed oil. By using white lead with common putty it will adhere better and become harder. Common white putty may be colored with ordinary colors to match the paint or stain which is being used. A little putty kept in a tightly covered jelly tumbler is often quite handy. As putty becomes hard by standing, some persons prefer to keep a supply of whiting and oil and make their own putty a little at a time as they use it. The hand mixed putty is not usually as good as the good grades of machine mixed. Do not use putty in any holes that can be plugged with wood. If the putty is too soft, wrap what you wish to use at one time in paper and in a few hours it will be much harder.

Rule

Probably no part of the shop equipment is so often improperly selected as the pocket rules. These should be selected for accuracy, convenience, and

to familiarize oneself with the rule which he is likely to use after leaving school. For this reason all two-foot, two-fold rules are unsuitable. Of the four-fold rules the number 84 is probably the best, price considered. In no case use the ten-cent style, or one having neither edge brass-bound.

Be very particular to use the rule exactly as directed. Many of the directions given may appear wrong or needless to those not familiar with practical work, but nevertheless every direction given is the result of much experiment and use. Whenever possible we should use the rulings away from the end, as shown in Fig. 17. The corners not only soon become incorrect from wear but very often the graduations at the extreme ends are not made correctly.

The number 84 rule and also the number 62 rule (Fig. 177) have the inches divided into eighths, sixteenths, tenths, and twelfths. These are a very useful variety of graduations, and you should accustom yourself always to use the rule in the same manner and then there will arise no trouble from getting the various scales confused.

Fig. 177. Pocket Rule. The No. 84 Rule is the same as this one except that only the outside edges are brass bound.

Hold the rule, opened to one foot long, in the right hand as shown in Figs 14 and 17, when using either eighths or sixteenths. The tenths and twelfths are on inside edges and therefore we never

use them by mistake if the rule is held in this manner. When opened to two feet long, if we always hold the rule on edge, the center hinge up, we are sure to use only eighths or sixteenths. To use the tenths or twelfths we must place the rule in an uncommon position.

The drafting scales marked one fourth, one half, etc., may be used to take the dimensions from scale drawings. The even inches are measured with the rule in the ordinary manner. The fractions of an inch are obtained by setting the compasses to the distance on the drawing and then applying them to the scale as in setting them, as shown in Fig. 99.

The proper method of using the rule in laying off given spaces is shown in Figs. 18, 123.

Sandpaper

Sandpaper is the name commonly applied to a tough paper coated with ground flint. Glue is used to hold the flint to the surface of the paper. There is considerable difference in the cutting and wearing qualities of the different brands of sandpaper.

For ordinary work the grades 0, $\frac{1}{2}$, 1, $1\frac{1}{2}$, are sufficient. For very fine work 00 may be used. No. 2 may be used in rounding corners, edges, etc. Such places should be made quite smooth with the edge tools before using the sandpaper. If your work is to be inspected by an instructor do not use any

sandpaper until the piece has been examined and passed. For nearly all small work it is best to hold the paper without a block as shown in Figs. 46 and 47.

On large surfaces and to give a smooth finish to corners and rounded edges a block may be used.

Plane a block to about $4\frac{1}{4}$ inches long by $2\frac{1}{4}$ inches wide and $\frac{7}{8}$ inch thick. Keep this block for use when required. Blocks of other sizes and shapes may be required for special work. These may be of almost any size or shape but should always be carefully made and the paper very carefully folded around them. Never glue or nail the paper to the block. Fold it so that it may be changed in position until the entire surface has been used. Remember that paper which has been used is often better than a fresh piece, and therefore do not throw any paper away until it has been entirely worn out.

Sandpaper often becomes too dry to work properly. If kept where it will not dry out nor become too damp it will work much better. It may be dampened by sprinkling a little water between the sheets and keeping them pressed tightly together for a few days. Always tear the paper carefully with a saw as shown in Fig. 44.

Saws

The saws used in elementary wood work are the hand saw, the rip saw, Figs. 178 and 179, and the back saw, Fig. 180. For special work we sometimes require the compass saw, Fig. 181. The proper methods of using the saws are shown in Figs. 37, 38, 72, 93, 94, 95. In using any saw in working around a curve the saw should work squarely through the piece, or at right angles to the surface in both directions. This applies particularly to the compass saw.

Fig. 178. The common grades of both hand saws and rip saws are made this shape.

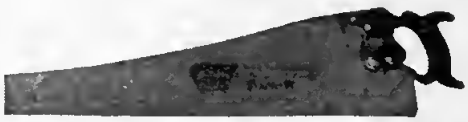


Fig. 179. Some of the better grades of saws are made this shape

The blades of saws are easily rusted and therefore you should not touch the blades with your hands. If from any cause the surface of the blade is moistened, or if they are used in a damp room, they should be carefully wiped and the surface coated with vaseline or oil. Vaseline is probably the best anti-rust material easily applied for keeping not only saws but all other bright tools from rusting.

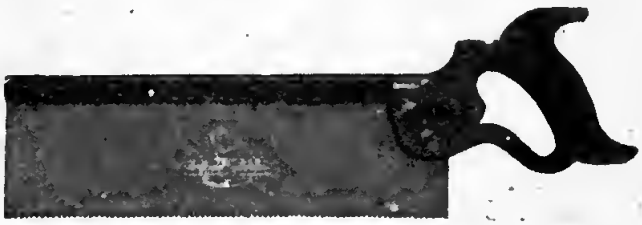


Fig. 180. Back Saw.

Fig. 181. Compass Saw

When the saw refuses to work freely it should be put in order. The kinking of the blade is a serious injury to the saw and therefore take no chances. When the saw sticks or binds in the kerf, find where the difficulty is and correct it or stop sawing entirely and wait for assistance. Of all the tools used in working wood, none work so freely as saws when in order and properly used and none so badly when out of order.

Fig. 182 indicates the forms of teeth usually given to small saws. A shows the teeth of a hand saw and B those of a rip saw. The shapes shown are only to illustrate the general plan of the two kinds of saws. This is especially true of the hand saw which is filed at many different angles to suit it to various kinds of wood and different grades of work.

Fig. 182. Teeth of Saws. A, Hand Saw. B, Rip Saw.

The fitting of saws in the best manner is too difficult a task for even many of those who are constantly using them. The novice in woodworking should not attempt to fit his own saws. After he has become quite familiar with his saws and knows quite well how they should work when in proper shape, he may begin by pointing the teeth a very little when they become dull. The first thing to be learned is that there is great danger of filing too much and that too much filing is quite as bad as no filing at all. After a time he may attempt to joint

and file and finally to joint and file and set his saws.

Fig. 183 shows a good clamp for holding saws while filing them. The boards should be a little

Fig. 183. Saw Clamp.

hollowed on the inside so that they will press firmly against the sides of the saw near the teeth. The saw should be held as low down in the clamp as will permit of holding the file at the proper angle. There are many kinds of saw clamps made of iron. These are good but not essential when one has but two or three saws to keep in order. It is very essential that a clamp of some kind be used, for if the saw is not held very firmly the files will wear out rapidly and it will be very difficult to make the teeth of the correct shape.

Saw Set

The saw set, shown in Fig. 184, is for setting the teeth of saws so they will work more easily. This is not a very difficult tool to use except that it requires considerable experience to determine how much set should be given a saw to cause it to work to the best advantage.

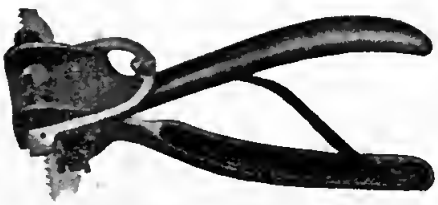


Fig. 184 Saw Set.

You should proceed with considerable care in order not to crush the teeth or kink the blade at the base of the teeth. There is also danger of breaking the teeth. The less set a saw has the better, provided it works freely. Some saws are made so that they do not require any set. This is generally true of the back saws and other saws which are thin on the back.

Scraper

For cleaning off thick bits of finish and for smoothing cross grained pieces a scraper is required. One may be made from a piece of an old or broken saw blade. Various sizes and shapes may be purchased. They may be rectangular in outline or of any other shape required to fit the work. For the present work a small rectangular scraper is sufficient.

Fig. 185. Scraper Bur.

The cutting or scraping is done by a very fine edge or bur which is nearly at a right angle to the surface of the scraper. This is shown very much enlarged in Fig. 185. To produce this bur the edge of the scraper is first draw filed as shown in Fig. 186.

Fig. 186. Drawfiling a Scraper

The draw filing is to make the edge square and straight except that each end is rounded a little. For some work the edge is curved the entire length. After draw filing, lay the scraper flat on the bench and rub the edge several times the entire length with the chisel, as shown in Fig. 187. The chisel is held nearly, but not quite, flat on the scraper. This smooths the edge and forces a bit of metal out as indicated in Fig. 188. Next change the chisel as shown in

Fig. 187. Laying the Bur.

Fig. 188. Bur Flat.

Fig. 189. Raising a Bur.

Fig. 189 and draw it towards you, using all the force you can. This will turn the bur as shown in Fig. 185. You can turn a bur on but one edge or on each side of all the edges, and if you are careful in using the scraper you will not cut your fingers on the edges. A little soapy water on the chisel will cause it to work better and avoid tearing off the bur.

Fig. 190. Pushing a Scraper.

Always hold the scraper firmly and as near perpendicular to the surface as the bur will cut. Remember that when properly sharpened and used the scraper will cut off shavings, and therefore do not use it when it is so dull that it removes only dust.

Fig. 191. Pulling a Scraper.

The scraper is usually held in one hand for scraping thick places on finish as shown in Fig. 49. For finishing rough places on wood it is held by both hands, as shown in Figs. 190 and 191. Whether the scraper should be pushed from you or pulled towards you depends upon the nature of the work and the strength of your hands. Do not use any handle or holder while scraping ordinary small work. Be careful to hold the scraper so that it will cut at the center of the piece and not round the surface. Change the position or direction of the stroke sufficiently often to avoid following the defects in the surface. Be careful not to scrape out the soft places and leave the hard grain above the remainder of the surface. For working in hollows a scraper like the one shown in Fig. 192 may be used.

Fig. 192. Swan Neck Cabinet Scraper.

It is nearly always best to go over a surface with the smooth plane before using the scraper. Only on a very cross grained surface should one try to finish with the scraper directly from the planing machine. Some machines plane so smooth that the surface appears to be perfectly smooth except to the experienced eye, yet unless the hand plane is used the scraper will not be likely to remove the roughness so that it will not show through the finish.

Screw Driver

Perhaps the most abused of all tools is the screw driver. There are many forms both for bit stock and for hand use. Those for the bit stock, Fig. 193, should be of good quality and well sharpened. In hand screw drivers one may get any style or quality desired. One of the best forms is shown in Fig. 194.

Fig. 193. Bit Brace Screw Driver.

The proper form for the end is a straight even taper from the extreme point to the largest part of the lower end as shown in Fig. 195.

Fig. 194. Hand Screw Driver.

Never stub the end of a large screw driver to make it fit small screws. Nor file a shoulder as shown in Fig. 196. This shoulder not only does it no good but tends to cause the corner of the blade to break more easily than it would if there were no shoulder at this point. A good screw driver properly sharpened, if of the proper size for the screw, will invariably break the head of the screw before being broken.

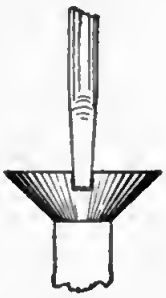


Fig. 195. End of a Properly Sharpened Screw Driver.

You should have different sizes of screw drivers so that the ends will fit tightly the slots of the screw heads. For elementary work the simple plain tools are the best. The various forms of spiral and ratchet screw drivers are excellent

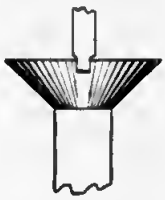


Fig. 196. Improperly Sharpened Screw Driver.

for some purposes, but should not be used until one has become quite familiar with tools in general.

Shellac and Alcohol

Use only the best white shellac in grain alcohol. Get this already for use if you can and avoid the trouble of fixing it. Be careful to get only that which is fresh, and which is made of good materials and properly mixed.

Good white shellac should dissolve in grain alcohol at the ordinary temperature of the work room. The proportions are best determined by experiment. The thicker the better, providing you are able to get a smooth finish. At first you will need to use it quite thin. Keep the bottle of shellac tightly corked, as the alcohol evaporates very rapidly. Fig. 201 illustrates a suitable dish from which to use the shellac. It may be covered quite tightly when not in use, and there is a wire across it on which to wipe the brush.

Fig. 201. Dish for Shellac.

Very fine finishes may be made entirely of shellac, but for elementary work it is not usually best to attempt more than to simply apply thin coatings of shellac and rub the surface carefully to a dead smooth finish after each coating. The rub-

bing may be done with fine sandpaper or with pumice stone and oil or water. Be very careful to rub the finish evenly as directed in Lesson 15. Remember that although shellac is probably the easiest finish for the beginner to use, it requires considerable judgment and patience to use it successfully.

Stains, Paint, etc.

The exercises may be stained or varnished or finished in shellac. There are many sorts of prepared stains which give a very serviceable finish. These may be had, with directions for use, of all dealers in paints and varnishes.

A very handy and cheap method of coloring soft woods is to apply a thin coat of any color desired and wipe off with a cloth until the grain of the wood shows through the paint. The common colors ground in oil and thinned with turpentine are used for this purpose. After the stain has dried the piece may be finished with a coat of furniture wax or a coat of shellac or varnish.

Strop

Do not depend upon the oilstone to give a perfect edge to either the chisels or the plane bits. It is nearly always best to finish sharpening the edge tools on a leather strop. Do not use the strop too much. The tendency is to round the edge, and this

should not be done. A very few strokes should be sufficient to give the tool a keen edge. In stropping tools the motion is the reverse of what it is in whetting them. The tool is drawn as indicated by the arrow in Fig. 202 and entirely lifted from the strop on the return stroke.

Fig. 202. Stropping Tools.

The expensive strops such as are used in sharpening razors are not required for this work. A strop may be made from almost any bit of leather two or three inches wide and eight to twelve inches long. With the scraper Fig. 191, clean the surface of a piece of heavy belting and you have an ideal strop for tools. Do not use any powder or other preparation on the strop to make it cut rapidly.

Steel Square

The carpenter's steel square (Fig. 197) is required by the young woodworker when cutting up stock, setting the tee bevel and for testing large pieces of work. The blades may also be used as straight edges. The small steel square with a 12 inch blade is very useful for small work. Do not be content to test one corner of a chair or frame, but apply the square in a variety of positions whenever possible.

Fig. 197. Steel Carpenter's Square.

Try-square

There are several forms of try-squares, some of which are shown in Figs. 198, 199, and 200. The method of using try-squares is shown in Figs. 4, 12, 19, 20, 21, 22, 23, 32, 33, 36, 42, 55, 56, 57, 59, 60, 62, and 95. All try-squares are liable to be injured by rough usage. Do not use them

Fig. 198. A Good Cheap Try-Square.

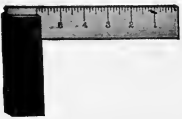


Fig. 199. A Substantial All Iron Try-Square.

for hammering or prying. Be careful not to drop them upon the floor or bench. In testing edges, lift and lower the square at several points along the edge rather than slide it the entire length of the piece. Always make a variety of tests if practical. Be careful to test pieces to their extreme limits, such as the extreme ends and edges.

Fig. 200. This Try-Square has an inlaid head and is probably the best try-square for use.

Should the square be bruised or sprung out of true it is not a difficult matter to true it by using the eight-inch file and testing it with the steel square.

Tee Bevel

Fig. 203 illustrates the common tee bevel. In this style the blade is held in position by the thumb screw at the end of the handle. The screw on which the blade slides sometimes requires adjusting in order that the thumb screw may hold properly. While adjusting the blade it should be just loose enough to move freely but not so loose that it will move without some force.

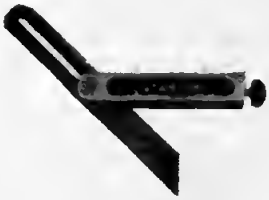


Fig. 203. Tee Bevel.

There are many ways of determining the angle at which to set the blade. Probably the best method

for the inexperienced is to first draw a line of the required angle as in Fig. 116. Another method is to set the blade by the carpenter's steel square by laying the head against one edge and, for a square miter, adjusting the blade until its edge is equally distant from the corner of the square on both the body and the tongue. The head may be placed as shown in Fig. 204A or 204B. You may have at hand the triangles used in drafting. These are excellent standards for use in setting the tee bevel to any of the angles found on them.

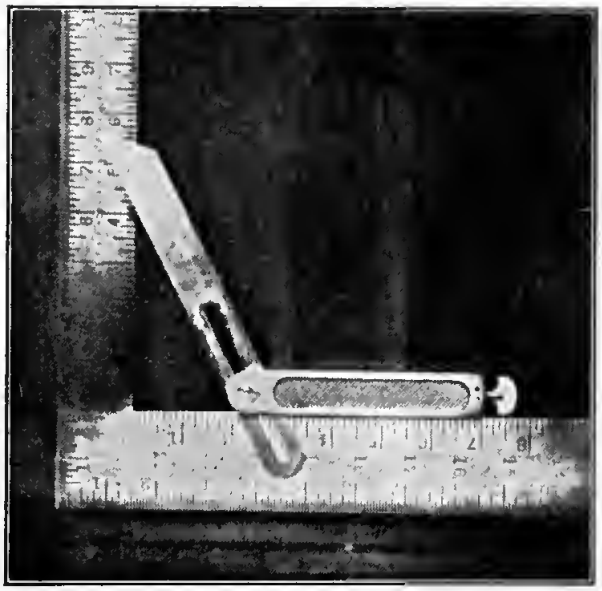


Fig. 204A. Setting a Tee Bevel.

There are many other ways of getting angles and setting the tee bevel, but the above will be found sufficient for all ordinary work. After the blade has been set at the desired angle it is used very much as the try-square is used as shown in Figs. 19, 20, 32, 33.

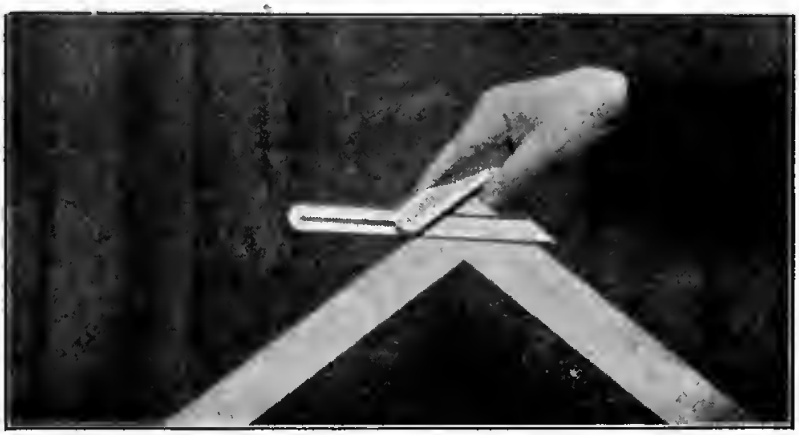


Fig. 204B. Setting a Tee Bevel.

Varnish

There are a great many varieties and grades of varnish. Each has its particular use. Those which give the better grades of finish require in their use considerable skill and experience. We cannot advise the use of varnish until one has become quite expert in the use of shellac.

Some "flowing" varnishes give fine finishes without any polishing. Some varnishes are made to be ground down to a smooth surface after drying. These are called rubbing varnishes. Some give a good cheap finish by having the articles dipped in them. Should you decide to use varnish, get it of a reliable dealer who will sell you the grade and kind suitable for your work.

The one point of great importance in all varnishing is that the surface to be varnished must be perfectly polished before any finish is applied if we are to have a proper finish. Use the scraper and sandpaper thoroughly, and do not forget that all defects and especially machine marks will show much more after the varnishing than before.

Vise

The vise should not be used to avoid the proper handling of the edge tools and the saws. Seldom, if ever, should any piece be held in the vise while using either a hand saw or a back saw. A good mechanic cannot use a hand saw or a back saw so well with the piece of work held in the vise as when it is held on a bench-hook, and it is useless for the beginner to attempt to do good work in this manner. You may succeed in cutting off a piece of wood, but you will neither have done a good job nor have learned anything of value. If you will not use the vise for such work you will not only soon be able to do more work, but you will be able to do better work and will also be learning the proper method of working.

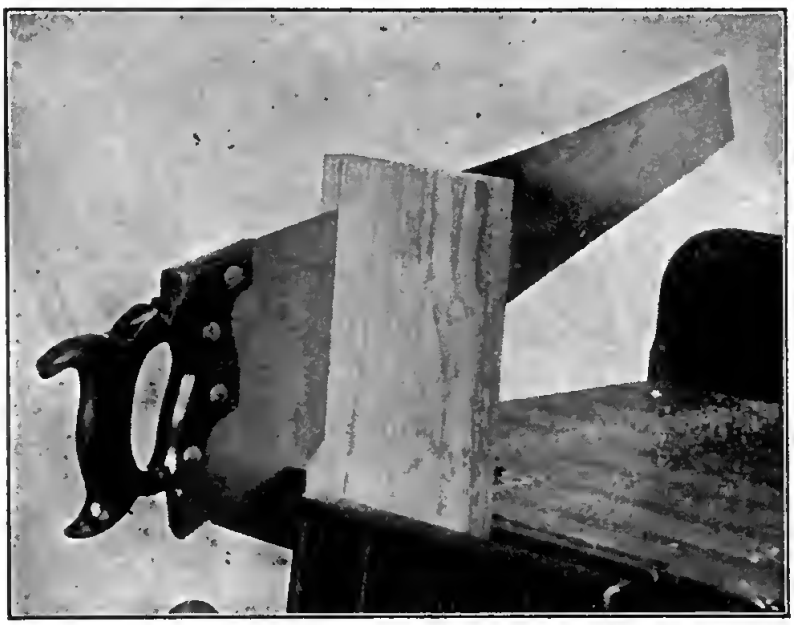


Fig. 205. Ripping in the Vise.

When a piece is to be ripped it should be held in the vise, unless it is too large, and then it

should be held upon the sawhorses as shown in Fig. 94. If the piece is too wide to be held as shown in Fig. 72, it may be held as shown in Figs. 205 and 206.

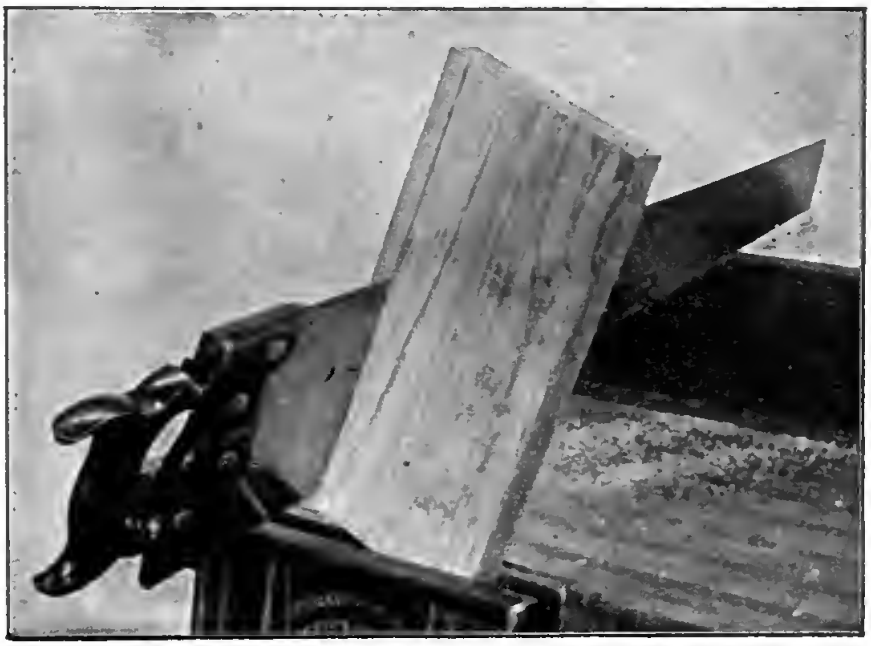


Fig. 206. Ripping in the Vise. Finishing.

The jaws of the vise should be of wood or lined with wood, and you should be very careful not to injure them with the tools. Also be careful not to overstrain the vise either by turning the screw too tightly or by placing the piece which is being held too near to one corner or edge of the jaws. It is sometimes a good idea with some vises to place a piece of waste material on the end or side of the jaws opposite to the work as shown in Fig. 207.

Fig. 207. A Block in the Vise to Hold it Square.

Proper methods of holding work are shown in Figs. 30, 31, 32, 33, 34, 61, 69, 71, 98, 103, 108, 117, 121, and 124.

The working of the soft wood joints should not be done in the vise but on the bench-hook, as directed in the lessons. When the work is in hard wood and much chiseling is required, the vise may be used, but not otherwise. Do not undertake to work hard wood until you have learned to handle your tools properly on soft wood, or you will likely not learn to do your work properly at all.

There are many styles of vises. The one shown in many of the illustrations represents a large number of styles of "quick acting" vises of more or less value. For the beginner there is no quick acting vise equal to the simple but old style wooden vise with an iron screw. These wooden vises may be seen in use by many woodworkers and especially by carpenters.

Wax

There are many varieties and grades of prepared wax on sale by dealers. Some of these possess considerable merit. Common beeswax made soft by adding a small quantity of turpentine is quite equal to any prepared wax.

The wax is first put on with a brush or rubbed on with a cloth or bit of waste and then the surface

very thoroughly rubbed. When the surface becomes dingy or loses its fresh appearance, more wax may be applied in the same manner. Wax is one of the safest sorts of finish to apply, but requires considerable rubbing to produce a good finish. There is little danger of applying too much, for any surplus will be removed in the rubbing. Where the wood has been first stained the rubbing must not be so hard as to remove the stain. This caution is especially necessary when rubbing around corners or on raised surfaces.

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